

A Study on Learning and Teaching Construction Technology Related to Design - A Case for Architectural Schools in Malaysia

by

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In the name of Allah the compassionate and the merciful.

***Untuk Mak dan
arwah bapak semoga dirahmati Allah***

***(To my mother and
the memory of my dear father)***

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Thesis Abstract

Analysis on the present architectural education system shows that there are problems with the understanding of construction technology in relation to the designing process. Earlier analysis of the problems showed that there are several underlying problems in the schools covering various aspects which pointed to the relevance of the current design practice, the experience and expertise on the parts of the lecturers and the updated references provided by the schools. The inefficiency of the schools in handling these underlying problems affecting the efficiency on the learning and teaching experiences of the subject. Accepting these problems, the study looks into the consequences of these problems in learning and teaching experiences of construction technology in relation to the overall understanding of design.

Architectural learning systems were reviewed and analyzed showing that the problems are largely due to students failure to grasp the basic principles of construction technology and relating them to the design process, in respect of forms and functions, time and places, and proper adaptation of design with art, history, philosophy, culture and technology. This failure affects the students overall performance in design. Consequently, effective learning methods and requirements to architectural education in the learning of technical matters specifically in construction technology is considered a significant area for study.

This thesis focuses on this issue. It tries to explore and understand the nature of the problems and aim to determine which methods or approaches appropriate based on theoretical formulation on the architectural learning requirements specifically for the learning and understanding of construction technology and its relationship in the designing process. It is therefore imperative that these theoretical formulation be based on empirical evidence. The purpose of this thesis is to conduct such empirical evidence.

Detailed studies were carried out on the historical development of learning construction technology in relation to the architectural design process, theories of learning and teaching methods adopted in the present architectural education in order to understand the problems and its relationship to each other. For a meaningful and effective learning experience, three vital ingredients are essential: the learning methods

adopted by the students, the prior knowledge (the experience) of the students, and the teaching methods employed. This thesis attempts to investigate these three components amongst architectural students and lecturers.

An exploratory interviews with the students and lecturers were carried out in Malaysia as a case study in order to understand the problems and the final investigation using the quantitative questionnaires were used to provide the empirical evidence.

Overall, the findings of this research support the following main conclusions: **First**, there are differences in the individual learning characteristics of the students. For example, those who have difficulties in understanding construction technology tend to associate themselves with rote learning, practicing sequential designing process, learning for passing examination and lack of motivation. Obviously, they are lacking in understanding the principles of construction technology thus, unable to relate these knowledge when he or she is working on a design. This empirical evidence revealed the first step in identifying key causes to the problems of learning and understanding construction technology in relation to the designing process.

The **second** finding is in the aspect of prior knowledge in construction technology (exposure and experience to pragmatic applications) which is found to be essential in providing a better understanding (meaningful learning) on the aspects of relating construction theories into the designing process. The results support the influence of experiential learning in architectural education system.

The **third** is in the aspects of the teaching methods whereby, teaching methods which promote experiences appear to be more needed by the students to the conventional teaching practices. Moreover, an inverse relationship on the methods of teaching construction technology preferred by the students and the lecturers were also found to be significant. This mismatched situation proved the gap in the teaching/learning requirements in the present architectural learning system.

Finally, significant relationships were found between understanding construction technology and the performance of the students in the designing process in the aspect of: the ability of the students to think construction and design (theory and practical) concurrently, to relate construction method, techniques and materials into design, to relate construction technology with the whole design requirements and to use construction technology as one of a design generator and hence, resulting in a superior design results and producing a more confident students. This implies that

understanding construction technology is interrelated with understanding on the practical application of construction technology into designing process as a whole.

Finally an overall conclusion of the study, its contribution, limitations and implications for further research are discussed.

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Chapter 1

Introduction

1.1 Background of research

1.1.1 Problems of construction teaching in Schools of Architecture

An analysis from schools of architecture in Malaysia revealed problems relating to the learning and understanding of construction technology. Students appear to be unable to understand and incorporate the construction theory learned in the classroom into their design process.

As a results of the researcher's own experience and observations it has been found that several schools are lacking in the present architectural learning system which is presenting underlying problems to the schools in general.

The following points were taken into consideration:-

Firstly, the relevance of the construction technology syllabus in relation to current design practices.

The rapid development of modern construction and material technology greatly influences the way students think and design. Their exposure to the modern building forms and available information from the internet, television, magazines, etc. influence these students to design complex building forms for example, following the ideas from famous architects like Frank Gehry, Norman Foster and many others, whose designs use most advanced technology of construction and materials. The schools should be fully aware of these changes required by the

students, unfortunately, the syllabus has remained unchanged for years and does not incorporate the latest developments.

Secondly, the study recognises the problem from the aspect of the lecturer's own expertise and experience in construction technology.

In any teaching and learning situation, the most important criteria to produce effective learning techniques is to have a good subject teacher/s. The expertise in construction technology and experiences of these teachers or lecturers plays a major role of the student's perception and learning ability of this vast and complex subject. It has been observed that most of the lecturers in architectural schools in Malaysia are new and not specialized in construction technology. This is becoming a major problem to the schools and in most cases their teaching abilities are being questioned.

The third factor is the lack of reference materials. Keeping the students updated to the new development on construction technology by providing reference materials which includes standard details, technical literatures such as video clips on new construction techniques and materials, problems and failures in buildings, models on construction joints, etc are in great need to the schools. Unfortunately, it is observed that, most of the architectural schools in Malaysia are lacking in such references which are vital to the development of interest and knowledge of students towards this subject.

Accepting the above as the existing problems, the thesis concentrates on the consequences of these problems in the learning and teaching experiences of construction technology .

1.1.2 Construction technology learning in architectural education

Almost in every architectural school, there is a clear definition of the lecture and studio. From much architectural literature reviewed, a "*lecture*" is defined as teaching or giving the student by formal discourse general principles or fundamental bodies of knowledge which guide and inform all aspects of the designing activity, whereas the "*studio*" is defined as the place where students apply the knowledge and

solve a particular design problem. Unfortunately, the experience of many lecture and studio teachers suggests this supposedly symbiotic relationship does not work as it claims to be. Many often complaint that “essential concepts they have taught about say, building construction do not seem to show up in the students’ design project” (Gelernter, 1988: 46). It follows that these lectures are treated as separate courses having their own time and space allocations. Little effort is consciously exerted to coordinate or synchronize on-going design projects with construction assignments.

The lack of coordination between design courses and construction technology courses (including working drawing, detailing, specification, contract documents and professional practice etc) has resulted in the establishment of the idea that design is the only creative and enjoyable process in architectural education. This has resulted in students becoming more appreciative in the creative aspect of designing and less concerned about technical matters which are equally important, when one is given the task of designing a building. However, this is further aggravated, by the fact that construction technology is essentially mechanical, even boring which makes the understanding of such subjects from its practical and theoretical aspects difficult to be understood by these students (Fethi, Mahadin et al., 1993)

Another striking observation is that the teaching of architectural detailing is separated from the teaching of design. This is extremely regrettable for good design has to be matched with good detailing. In fact it would be difficult to think of good design without an equally good and creative detailing of architectural components.

In architectural theory and criticism, both in theoretical lectures or during tutoring, detailing and constructional ideas are not emphasized by instructors. Priority is nearly always given to solution of plans and elevations. This rather passive attitude towards the practical aspects of architectural design has had a negative and direct impact upon the quality of architecture in Malaysia today. The overwhelming majority of buildings show an alarming disregard for sensible and creative detailing. In this setting, construction documents and detail drawings are often left to draughtsmen or young inexperienced architects or even to contractors who are asked to produce ‘*workshop*’ drawings.

1.1.3 Construction courses are not taught creatively

It was found in the survey (in Chapter 6) that most instructors who teach construction courses are not specialists in their fields. More often than not, they seem to lack the essential practical experience to teach such topics. Because these practical courses are regarded as somewhat sterile (homogeneous) and non-creative, they are in many cases assigned to unwilling or inexperienced lecturers. It is not surprising, therefore, that most architectural students find construction technology courses essentially a chore and even a waste of time.

Even though most schools in Malaysia teach construction technology from the first year to the final year, usually, final year students are required to produce some form of detail for their final year projects. These projects, however, are not usually graded meticulously. Most of the time allocated for construction and working drawings is usually spent in studios. Here students spend many hours reproducing drawings often copied from textbooks such as Mitchell's and McKay's or Barry's, all of which are essentially relevant to western building techniques and not to Third World countries like Malaysia (Abu Bakar, 1992; Fethi, Mahadin et al., 1993; Khan, 1987). Consequently, details are copied without adequate understanding of their overall system or technological context.

Courses which deal with the history of local building techniques and traditional or vernacular construction are very rare in Malaysian architectural schools. Such courses, if any, tend to concentrate on architectural typologies and stylistic developments. Rarely do such courses cover in detail local building materials and constructional methods. This is especially disconcerting because such coverage would be extremely useful and interesting for students because Malaysian architecture is full of traditional patterns which show rich lessons in building techniques. Lectures in construction and building systems tend to repeat western textbooks and are rarely coupled with slides or other form of visual aids that explain local case studies or examples.

Reviewing the contents and descriptions of construction courses reveal that they are set and stereotyped along the usual array of building components - foundations, floors, walls, roofs, windows, doors, joints, etc. Little attention is paid to systems or systematic construction, and even less coverage is given to building failures and their causes. Emphasizing the causes of building failures within the context of construction can be an impressive and interesting pedagogical methodology. Showing students what not to do and what to avoid can be a very effective tool in explaining what good construction and details mean in architecture.

Because of rapid developments in modern construction, materials and technology, the faculty in charge of teaching these fields should be fully aware of such changes. However, course descriptions in most schools have remained unchanged for years. It is observed that little development and innovation goes into construction technology courses.

Few schools currently have construction laboratories where students may see and feel full scale models of construction components, materials and joints. None have outdoor building labs where students may physically construct building components such as walls, arches, domes and so on. The absence of construction labs is a serious defect in architectural education today. Construction should never be regarded as a "paper" assignment.

Visits to construction sites in the locality of schools are not common, and are not usually incorporated within construction courses as an integral part of the teaching process. Because of logistical requirements and the large number of students, lecturers prefer teaching construction in studios or class rooms.

These preceding observations show clearly that construction technology courses are taught in a mechanical way, devoid of creative techniques, and are not closely related to their local or regional contexts. Few schools seem to have updated their curricula in this regard and most have not fully introduced alternative learning aids such as computer facilities as indispensable tools for current professional practice - both in design and in construction technology.

1.1.4 The ineffectiveness of current training methods

Architecture is a professional discipline and practical training for students, therefore, should be an integral part of the educational process. Although the survey revealed that most Malaysian schools have practical training periods ranging from 3 to 6 months as a prerequisite for graduation, such training has proved largely ineffective and in most cases only a formality.

Third or fourth year students are usually asked to nominate private or government firms for training for one term of the training course. They are also required to produce a document which certifies such training. Most schools don't seem to bother to inspect these students during training and the whole process is largely unchecked. In addition, governmental institutions are often reluctant to train

students because this necessitates burdensome logistics on their part. Private firms on the other hand, use students as a source of cheap labour and don't really train students as required.

1.1.5 Critics from the public and professional

Public and professional critics argue that there is a lack of architectural refinement in what has been produced in architectural schools where the emphasis has been put onto creativity on the basis of fantastic forms more than the commitment with the realities of the world of practice (Buchanan, 1989). In like manner, there are always questions raised in reference to the compatibility of subjects taught in the university and the skills required by the professional practices in the real world (Gutman, 1987; Burnham, 1988; Owen, 1990).

In due time, "architects" produced by universities that are lacking in practical skills will have to face the complexities of the real world. This is more so, with rapid development of design and progressive construction technology which will add more difficulties to these young architects. However, these graduates will have to design, detail and also to supervise complex and costly projects. With such little experience and technical knowledge, these architects will encounter great difficulties; it will also hamper organizational efficiency and at the very worst might even jeopardize the safety of the public.

1.1.6 The paucity of research in construction technology

Reviewing the few technical periodicals by Malaysian universities today, one is struck by the lack of research in building construction technology. Even Building Research Center, takes little interest in construction technology and tend to concentrate on building services, environmental properties, planning requirements, acoustics and costing. Only a few architectural schools publish periodicals, and these are largely concerned with theory and history topics. The '*measured drawings*' which is normally produced by the second or the third year students as part of the requirement for the construction technology courses are left unpublished. While there has been several studies and post-graduate theses on pre-fabricated building systems, very little research has been carried out on current construction

techniques, detailing, joints and performance of materials. Most schools do not seem to be interested in assessing the constructive performance of buildings within their locality.

Faculty research and graduate studies by students in construction could play a major role in enhancing the quality and credibility of academic courses. Such research would enrich the experience of faculty and provide them with necessary feedback, and would update their practical knowledge in local building construction and newly evolving techniques in their locality.

To sum up, we are very concerned with the problems and with the almost total absence of coordination between design (both as theory and studio work) and construction technology. This is most worrisome because it throws serious doubts on the credibility of these costly institutions to "produce" qualified architects.

1.2 Statement of research problems

With what has been described in the research background, we now arrive to the main purpose of this study which is to investigate, the relevance and contribution of learning theories to architectural education in particular the learning and understanding of construction technology in relation to the design process in the Malaysian context. The aim is to establish the extent to which learning behaviours and the teaching methods have an impact towards the pedagogical development of architectural education, and to explore the problems faced by architectural students towards the understanding of construction technology.

In the literature review, some important early analysis based on observations and problems were ascertained:

1. Analysis on present architectural education shows that problems in understanding construction technology have until recently received little attention from learning theorists in spite of their importance in architectural education. Evidence from literature suggests that despite this, there is a clear bias towards design; construction technology is taught largely as a distinct and separate discipline to design (Meunier, 1980; Ledewitz, 1985; McSheffrey, 1985; Peters, 1986; Gutman, 1987; Owen, 1990; Abu Bakar,

1992; Reno, 1992, among others). Furthermore, it is reported that the subject is not taught creatively and that current training methods are ineffective (Khan, 1987; Fethi, Mahadin et al., 1993). This also applies in the Malaysian context.

Studio design is the foundation of an architectural teaching program. It has failed, however, to integrate the principles of building construction in respect to form and function; time and place; and proper adaptation of design with art, history, philosophy, culture and technology. Because of this, effective learning methods and requirements for architectural education, specifically in technical matters, are considered a significant area for study.

2. The understanding of construction technology is also subject to external factors, one of which is the teaching method applied through lectures. The teaching method employed by lecturers appears to be inadequate to equip students to understand the subject better (Meunier, 1980; McSheffrey, 1985; Peters, 1986). The students appear overwhelmed with large amounts of complex technical information to the extent that they resort to stereotype solutions which are largely devoid of contextual consideration and lack the essential qualities of rational and workable architecture. It must be emphasized however, that this situation is by no means exclusive to Malaysia, indeed it has become a symptom in many architectural schools world-wide (Khan, 1987; Fethi, Mahadin et al., 1993). This statement reflects that there is a great gap between the external learning factor (which is the teaching method employed) and the internal learning factor (which comprises the learning method and educational background of the students).

Unfortunately, an empirical analysis of learning and teaching methods in architectural education has not been fully conducted. Lack of such studies make it difficult to understand the nature of the learning environment that architectural schools are facing. This in turn makes it difficult for academicians to employ proper problem-solving techniques. Greater emphasis, therefore, must be placed on examining the external learning factors relating to the teaching phenomenon which affects the learning behaviour of students in architectural schools. This is one of the approaches adopted by the current study in examining the teaching/learning behaviour of Malaysian architectural schools.

3. Critics from the general public and professional bodies argue that there is a lack of intricacy and refinement in what has been produced in architectural schools (Teymur, 1992; Fethi, Mahadin et al., 1993). In like manner, there are always questions raised in reference to the compatibility of subjects taught in the university and the skills required by professional practices in the real world (Gutman, 1987; Burnham, 1988; Owen, 1990). The statement reflects that "architects" produced by universities are not only lacking in professional and practical skills, but in knowledge and competency. Again it may be useful to examine the internal and external learning factors and their effects on the performance of students in design as a whole.

1.3 Objectives of the thesis

Having outlined the research area, the study now summarizes the major research objectives:

1. To investigate the key issues and problems relating to the learning and understanding of construction technology and its relationship with the design process.
2. To investigate whether there is a gap between the internal learning factors (student's learning method and learning background) and external learning factors (teaching methods employed) in the present architectural learning system, which may be the key causes to the problems of integrating construction technology into the design process.
3. To identify the main learning requirements necessary for attaining internal and external learning factors leading to a better learning performance and eventually producing knowledgeable and competent architects.

1.4 Organisation of the thesis

The remainder of the thesis will consist of eight chapters organised in the following sequence. In Chapter 2, we will look at the historical development of architectural education and the reasons for the development. The review on

architectural education begins from the early traditional process to the highly specialised methods of architectural training. The progress and the development of architectural education then underwent several years of evolution and modifications due to different constraints and requirements set by the public, environment and technology. This will unveil the learning or teaching methods adopted and more importantly it reveals the importance of integrating construction technology with design as one learning system. The study of construction technology itself can be very broad, and the main focus of this thesis is not to study it in detail but to know why and what makes the learning of construction technology difficult.

The background study undertaken centres on the problems faced specifically on learning construction technology. The next step is to focus our analysis on the design process and the integration of construction technology in the design process. Thus, Chapter 2 enables us to understand the problems and difficulties in understanding construction technology and more specifically, on the integration of construction knowledge in architectural design process.

Chapter 3 analyses higher learning in Malaysia. This is to familiarise the reader with the learning environment including the accreditation and validation processes of the university, professional expectations and the structures of the training programmes of universities which offer architectural studies in their programmes. At the same time, we also analyse specifically the problems on learning construction technology in order for us to further understand the problems.

To help us understand the complexity of these problems, the research will look into views from the learning theories. In Chapter 4, an attempt is made to understand the nature of learning from early childhood to adult learning. The focus will be more on adult learning with emphasis on learner-centered learning. The chapter concentrates on two main theories of learning forwarded by the Behaviourists and the Cognitivists. This is augmented by views of several well known learning psychologist on learning of architectural students. By understanding the learning psychology of students, we hope to understand the learning requirements of the individual. At this point, problems affecting the learning of construction technology and their relationship with performance of the students in design are identified and understood. In addition, we also investigate the teaching methods preferred by students. Here, we hope to detect the shortcomings of this learning system. Lastly, we also provide suggestions to rectify the problems.

Based on the above factors, a research framework and preliminary hypotheses are developed. A detailed discussion on the research design, methodology, survey, sampling and data analysis is also forwarded. All of these will be discussed in detail in Chapter 5.

Chapter 6 discusses the different learning (internal learning factors) and teaching methods (external learning factors) affecting the performance of the architectural students by way of interviews. More importantly, the chapter presents the results of these interviews (interviews with students and lecturers) which are used primarily in the designing and constructing of the second stage of the data collection - the questionnaires.

Chapter 7 discusses the empirical analysis using quantitative methodology. Quantitative methods are generally associated with systematic measurement, experimental methods, statistical analysis, and mathematical models (Linn and Erickson, 1990). The quantitative methods involved in this research are the use of questionnaires, and statistical data analysis. The identification of major and potential issues is forwarded and this is followed by hypotheses testing. This chapter presents the results of several tests which were performed on students and lecturers from the architectural schools in Malaysia in order to understand their relation to the hypotheses outlined earlier. Each hypothesis is presented and is followed by the appropriate confirmation procedures with an ensuing discussion from previous research. For ease in understanding, a summary of the results of the hypotheses testing is tabled.

Finally, in the concluding chapter, Chapter 8, we present a review of the thesis. The main findings, conclusions and practical recommendations are discussed. The chapter ends with a discussion on the limitations of the research methodology, direction for future research and the contributions of the research. The surveys schedule (interviews and questionnaires) and other supportive documents follow in the appendices.

Chapter 2

Architectural Education and Construction Technology

2.0 Introduction

Most of the architectural designs are directly or indirectly influenced by a combination of three aspects: First, the historical context, which reflects the awareness of the past, culture and tradition, second; philosophical which is inspired by formalism and symbolism; and third, technology which evolves around the application of building materials and construction techniques. Each of these issues has a great influence to design education in schools of architecture. It therefore becomes necessary in any discussion on architectural education to understand the evolution of the discipline of architecture as an educational process and be critically aware of its strengths as well as failings that can be discerned along the line so as to develop a sounder model for the present.

This chapter looks into the development of architectural education and a review of the reasons for this development. The issues and problems related to this evolution in particular, on technical subjects in the architectural curriculum will be explained in detail and later focusing on the problems faced specifically in the integration of construction technology with design.

2.1 An overview of the development of architectural education

The discipline of architecture has undergone several processes of evolution. In the past design activity was carried out through the process of '*craft evolution*'. Before designing by using paper, man had created objects for their needs including shelter, tools and means of transportation. These objects were created practically based on functional requirements with the influence of surrounding nature. The process often lacked any theoretical background. Lawson (1990) refers to this

approach in design as the '*blacksmith design*' in which the craftsmen traditionally designed an object as they made them. In other words *the design of a vernacular craft is actually the 'making' of the object*. The skill involved in the making of the object has descended from one generation to another without any form of systematic transfer of knowledge. A good example of the vernacular craft is found in the design of a traditional tribal shelter such as an igloo. Broadbent (1973) describes,

"Almost every member of the tribe knows how to build an igloo. He can cut a block of snow, place them in a wide, often tapered as to form the basis of spiral, and then piled other block up and over to form a dome. He then fills the gap between block with snow." (Broadbent, 1973: 28)

Such ingenious creation is the result of a traditional form solution that suits the functional requirements. However, the igloo is built without any theoretical principle involved. The design is supposed to fulfil the requirements of the user according to its function, climatic and cultural setting. The design method and technology is passed from generation to generation with modifications and trial and error to suit the place and time. Alexander (1964) also explains the craft process which he calls the '*unselfconscious*' process because of its gradual evolution. Alexander pointed that there were no formulated rules in the craft design process. However, there are unspoken rules and firm traditions practised among the craftsmen. According to him, the vernacular process of creating buildings shows that craftsmen do not and often cannot draw their works. In addition, they cannot always give adequate reasons for the decisions they take. Furthermore, the form of craft product has been modified by countless failures and success of trial-and-error over many centuries. However, it produced an astonishingly well-balanced result and a close fit to the needs of the user at that particular time and place.

This tradition was practised till the *Renaissance*. During this period architecture was becoming more stylistic which was influenced by mainly its structural and construction techniques using a limited number of materials including stones, bricks and timber. Later, the traditional role of a designer-builder was then reduced to producing drawings, and providing information for other people to construct his design. In other words the design process evolves from the process of making to a conventional process of designing, or what Jones (1980) calls design-by-drawing, where one has to draw before an object is made. This new conventional process separates design from making which undermines the craftsman's previous autonomy and authority in his work. Perhaps this marks the beginning of formal methods of architectural training. However, the training of architecture continues

through a system of *apprentice* where potential designers studied under the supervision of one or more experienced designers. The novice entered into the profession as an initiate and gave himself up to the '*masters*' to be trained at a very young age. The training itself encompassed the technical knowledge of the art or the craft as well as the social ethics of the discipline. Later, in the late eighteenth and early nineteenth centuries, it gradually change to a *pupilage* system where formal education was combined with workshop and office works (Crimson and Lubbock, 1994) .

With the influence of the Modern Movement in the late 1950s, people were then beginning to realise that architects had failed to absorb new scientific and technical knowledge in their designs. The Oxford Conference on Architectural Education in 1958 marked a major turning point in the architectural profession and education. The conference agreed that architectural education should be a full-time graduate taught course and that the entry to the course required a matriculation system and academic examinations. Graduate architects would become professionals equipped with not only theoretical knowledge but in management skills. This means that the traditional apprentice *pupilage* system and the bond between the designers and the builders which form part of the educational system was discontinued. This resulted in many unsatisfactory remarks from many architectural academicians and researchers. They believe that the change in the system will not only make architecture more biased towards theory rather than practical but the more depressing thing is that it reduced the bonding between practitioners and the educational process. Murta (1986), who analysed this problem said,

"... there was a growing alienation between educationists and practitioners and a feeling that this alienation was leading to a poorer rather than better design standard."

This is supported by his reference to a study carried out by Building Research Establishment which showed that there was a large number of failures in a sample of 400 buildings, in which more than 60 per cent could be attributed to faulty design.

The separation between educationists and practitioners has affected the curriculum in the architectural education and in one way or another affected the performance of the students. For example, there has been tremendous development in the building industry particularly in the area of building technology, new building materials and construction technology have changed the architectural scene drastically. Beautiful and innovative buildings were built in which some were

labelled and categorised into different architectural styles based on their forms and architectural philosophy. On the other hand, there was not so much development in the architectural curriculum as compared to that of the practice. Buchanan (1989) said, "architectural education is in a sorry state. It failed to keep up with the rapidly changing building industry." The statement supports the issue which indicates the **gap between architectural practice and education** in which at one time they were under the same roof.

This gap between architectural education and practice also resulted in numerous pitfalls and problems in architectural education. Reviewing our present architectural education, researchers such as Ledewitz (1985) pointed out that one of the problems highlighted in architectural education is in the integration of technical knowledge with design. Students are not able to integrate the theories delivered in studios and the pragmatic aspects of the project. According to him one of the most common reasons for this is that students tend to be influenced by architectural forms and 'styles' which are found in glossy architectural journals and periodicals. Students are normally influenced by the aesthetic characters and forms which usually drive them to imitate. Unfortunately, they do not necessarily realise and understand the reason for such form or style and the true requirements on the aspects of construction and materials used in the design.

On the part of the teachers or lecturers they too seem to neglect the importance of construction technology in design. The theoretical aspects - including the forms, space and philosophical aspects of design have dominated design education. Reviewing this phenomena, Peters T. F. (1986) stated that,

"In our culture, technical subjects have always been the stepchild of architectural education and have been largely neglected. The formal, spatial and theoretical aspects of design have dominated design education so far while the neglect of the technical component has slowly boiled up a crisis in architectural education with the NAAB (National Architectural Accrediting Board) and practitioners demanding quick changes and schools often slow to react". (Peters, T. F., 1986: 1)

Obviously, the evolution on the part of architectural production has resulted in various advantages and disadvantages to the development of the architectural curriculum. The evolution not only change the structure of architectural training but the development on the part of the curriculum was stretched out almost in every living aspects including art, history, culture, sociology and most significantly by technology. With all the different constraints and requirements set by these

disciplines, the challenge seems to lie in the ability of the school to train these future architects to be able to *juggle*¹ these requirements involved in the architectural production.

The preceding section described the nature of design in general. Here, it would be necessary to distinguish architectural design from other forms of design, and the section later focuses on the approaches in architectural design process.

2.2 Understanding Design

Almost everything around us - buildings, clothes, furniture, machines, high technology systems, etc. - has been designed. Design can represent many varied situations that appear to have little in common. Compared with the vast amount of design activities going on in the world, the nature of design itself is rather poorly understood. This is one of the reasons why there are so many theories to understand the nature of design.

It is generally recognised that design falls somewhere between two extremes: science and art. It is considered that engineering design is close to the scientific extreme while clothing, pottery or fashion design is close to the artistic extreme and **architecture design lies near the centre of the spectrum**. Such a diversity of design prevents a unified definition about design and a unified description of the design process. All definitions of design are partial. About the efforts for defining design, Sargent (1994) concludes that there can be no unitary 'science of design' although any number of empirically verifiable partial theories are possible. Abel (1982) suggests that the ideal situation would be to have as many definitions of research on design as there are researchers.

Reviewing researches on design, we agree that most of researches on design tend to focus on design method and creativity. This is based on the assumption that there are two ways of thinking - logical, analytical and rational on the one hand, and subjective, idiosyncratic and irrational on the other. The development of design methodology started from the first viewpoint which is the scientific viewpoint while the creativity aspect of design is influenced from the psychological foundation - the subjective idiosyncratic and irrational. In both cases, each approach has evolved to bridge the gap between the two origins.

¹ Lawson, (1993)

Although a clear distinction between the two approaches is difficult and these two approaches do not succeed to fully explain the nature of design, it would be possible to have an understanding of design for each individual purpose by understanding how designers think. The following section explains the basis for understanding design.

2.3 Design Thinking

Different ways of looking at design result in a variety of approaches for dealing with it. How we see architectural design effects on the manner of designing. For instance, Gauldie (1969) sees the variety of architecture as follows:

“Every building is in some degree a historical document, a demonstration of structural technique, a performance test of building materials, a comment on the values of the society which produced it, and a reflection of the richness or poverty of its designer's imagination” (Gauldie, 1969: 2).

If we see architectural design as a subset of environmental design, architecture has a practical as well as an artistic purpose. Architectural design has to do with the creation of physical objects or places which accommodate human or social activity and which are intended to change such an activity. Architectural products are solutions to problems coming from the environment, and the solutions also have a retroactive effect.

“... In general we may say that architecture is a human *product* which should order and improve our relations with the environment” (Norberg-Schulz, 1985: 21).

Some can see architecture design as an art, as stated by Christian Norberg Schulz (1969) in (Baker, 1989: 10) “architecture belongs to poetry and attain a poetic dimension when buildings gather the properties of the place and bring them close to man”. On the contrary, Baker (1989) argued clearly that architecture is distinct from the other arts, which all can be dispensed with, as we can remove a painting, choose when to listen to music, leave a book on a shelf. On this account he said:

“Architecture, unlike music, painting or literature, is of the earth. It belongs to the **ground** as a container for the activities of man as such is part of his very existence. This intrinsic link is evident in the basic need for shelter “ (Baker, 1989: xix)

To him (Baker), architecture is the framework for personal or family life which thereby represents the prime characteristics of a culture. Because of this, he believed that design should respond to factors or '*forces*' which are site conditions, functional requirements and culture. He added that the state of advancement of the culture will affect the kind of structure and materials used later.

Traditionally, architecture design thinking has been described to be characterised by at least three aspects: functional, technical, and aesthetic. Norberg-Schulz (1985) supplements social and cultural features and suggests another four aspects: physical control, functional frame, social milieu, and cultural symbolisation. The physical control is interconnected with particular functions, and the functions on their hand are determined by social condition which presuppose the existence of cultural objects. Architecture depends upon the selection of viewpoints, i.e., intentions. According to him, the form of a building is the product of a whole series of successive intentions, woven together either successfully or unsuccessfully.

In a similar context, Hillier et al. (1972) define design of a building as a realisation of a number of social functions with an effect of ecological displacement and suggest four-function model of a building: climate modifier, behaviour modifier, cultural modifier, and resource modifier. Markus et al. (1972) also emphasise the relationships between buildings and people. They developed a descriptive model consisting of five main parts: the objective system, the activity system, the environment system, the building system and the resources system. People are assumed to be goal oriented in order to achieve objectives. These objectives provide the context for all the activities and hence for the buildings and environment.

Forms, colours, spaces, etc., of architecture are media through which architects communicate to the society or to the users. Elements of architecture themselves do not contain any significant meaning. These elements are amalgamated to reflect social, cultural milieu and other design constraints through the process of achieving a set of intentions or goals. Fundamental differences in the social, cultural context or in architect's knowledge and experience will cause fundamental differences in the realisation of architecture.

With the above it gives us quite a comprehensive discussion on architecture design itself and factors influencing on how designers' think. However, according to Archer (1979) there is a '*designerly*' way of thinking quite appropriate to the kinds of problems designers tackle:

“There exists a designerly way of thinking and communicating that is both different from scientific and scholarly ways of thinking and communicating [...]. Human beings have an innate capacity for cognitive modelling....” (Archer, 1979: 17).

This approach, in which researchers try to understand how designers design or what goes on inside the designer's head, inevitably relies on methods of inquiry drawn from psychology and the study of human cognitive performance. The next section gives an overview of cognitive aspects of design based upon the psychological foundation. It could give us a better understanding of design with the scientific approach. Detailed investigation on this topic particularly on the aspects of its contribution to learning architecture will be discussed later in Chapter 4.

2.3.1 Design thinking based upon psychological foundation

Thinking is one of the most difficult aspect to understand since the thought process is not easily seen. In the study of psychology, the simplest way of studying the thought process would be to directly observe his behaviour. In Behaviourism, behaviourists argue that it is unnecessary to hypothesise a complex mental mechanism because according to them behaviour can explain these processes. Thus, the subject matter of psychology must be restricted only to what can be directly observed. This approach tends to explain problem solving or goal directed thinking in terms of successive mental trial-and-error without wilful control of direction.

In contrast, gestalt psychology concentrates on the process and organisation rather than the mechanism. It emphasises that the whole affects the way in which the parts are perceived. Gestalt psychologists consider problem solving as grasping the structural relationships of a situation and re-organising them until a way to the solution is perceived. Although they failed to develop precise theories and methods, perceptual phenomena (especially visual), such as '*figure and ground*' or '*convex and concave illusion*', etc., discovered by gestalt psychologists give significant influences on design principles.

The new cognitive approach of human thinking views people as complex, active organisms who use plans, rules, and strategies in experimental and real-life situations. It deals with the process and operational function rather than the physical mechanism, and it stresses the influence of the context in which problems are perceived on the thought process itself. It assumes the existence of some kind of

executive controlling function in mind. Since cognitive psychologists accept that information is actively reorganised and reconstructed in memory rather than passively recorded and recalled (Hilgard and Atkinson, 1967; Bolton, 1972; Haber and Hershenson, 1973; Mayer, 1981; Tuckman, 1992; Biehler and Snowman, 1993) , it follows that something must control this process. Information processing theory plays a significant role of controlling this process. - learn, store, manipulate and remember information as well as solve problems, and provide reason/s for an action or activity.

Therefore, cognitive psychology provides a firm basis of objective understanding of the nature of design and how it relates to the other aspects connected to it.

2.4 Design as creative thinking

Creative thinking is one mystical realm that refuses to yield its secret. According to Jones (1969), there are at least three approaches to understand creativity in design: *glass-box*, *black-box* and *skill*. In the glass-box approach, creativity is considered as a systematic activity which can be drawn as a map similar to those of the design process. In the black-box approach, there exist enormous individual differences in the level of creative talent defined as “creative personality”. The last approach sees creativity as a skill which can be developed and practised. In all cases, creativity is a difficult word to define. Halpern (1984) suggested that a definition of creativity must include a sense of originality, uniqueness, or unusualness. As De Bono (1992) said, "...no one calls creative something new which he dislikes". There could be no objective criteria to assess creativity. Creative thinking is evidently a somewhat vaguely understood idea, and it seems to have different meanings in different contexts.

Traditionally, creativity has been explained by two modes of thinking: convergent and divergent thinking (Guilford, 1967). A similar dualism has been suggested by De Bono (1970) as '*vertical thinking*' and '*lateral thinking*', and by 'brain researchers' as '*left hemisphere*' and '*right hemisphere*' (Tovey, 1984) . Although, as Guilford said, divergent thinking plays an important role for creativity, it is generally accepted that design problem solving involves both convergent and divergent thinking. The design situation may determine which mode will be dominant. (Lawson, 1990) argued that science cannot be solely explained as convergent thinking, nor that art or design require only divergent thinking.

“Some artists work in an entirely original and creative way while, others may follow traditions, developing ideas but not breaking fundamentally new ground. Not all artists are generally considered highly creative, but even those that are clearly demonstrate qualities of perseverance and single-mindedness not usually associated with divergent thought” (Lawson, 1990: 116).

Lawson pointed out that design involves various degrees of creativity. There seemed to be a general acceptance of the classification of design into routine, innovative, and creative (Gero, 1990; Schmitt and Chen, 1991). In fact, few design problems require completely novel creativity. However, nobody could say that extreme routine design does not need any creativity. Even some of the most creative design work is a routine base design.

Creativity in design thus requires a balance of convergent and divergent thinking abilities to the situation. It is important for the designer to recognise the nature of the problem and to employ convergent and divergent thinking in appropriate rates. What makes the thing more complicated is that not only the problem but also the solution and the designer himself all influence the design situation. Although there exist several design methodologies which view the design from the scientific point of view, the experienced designer has acquired his own design process for coping with the complicated design situation by trial and error. It seems that, from the creativity point of view, what is needed is not the systematic design methodologies by which the optimal solution is generated but the guidelines or strategies by which the designer can obtain his own way of designing and be an experienced designer. Some of the creative strategies can be applied to design are **visuo-spatial thinking** (Tovey, 1984, 1986) and **reasoning by analogy** (De Bono, 1970; Rowe, 1982; Broadbent, 1988).

Another important aspect of creativity is the goal directed characteristic (Weisberg, 1992). Accidental discoveries are not meaningful without being recognised by someone who is interested in or eager to discover the phenomena.

Besides thinking modes, many psychologists have emphasised the importance of **experience** and **knowledge** for creativity. Laxton (1969), in a discussion of design education in schools, suggested that children cannot expect to be creative without a **reservoir of experience**. Hayes (1978) argued that creativity can be enhanced by the following means:

1. Accumulation of knowledge - experience,
2. Create the right atmosphere for creativity and
3. Searching for analogies.

Another important characteristic of design creativity is cumulative design knowledge. As Schön and Wiggins (1992) said, design knowledge can be accumulated as the designer gets more experience through many projects. We speculate that designers are able to store the discoveries that result from past projects, carrying them over to new design situations that trigger them, on the basis of features perceived as similar (Schön and Wiggins, 1992: 155).

Akin et al. (1986) conducted an interesting experiment to show the behaviour of expert and novice designers. Their findings indicate that the novice designer started a design from design requirements (partial details) to abstract concept and adaptively generated a solution, whereas the expert designer developed a scenario (a large chunk of functional knowledge) to capture broad features of the design. They speculate that the expert designer may rely on his domain experience to infer the scenario relevant to the design solution under consideration. Schön and Wiggins (1992) explain that the novice designer begins to work in one domain. However, the expert designer can work simultaneously in many domains. A similar experiment is carried by (Rambow and Bromme, 1995) . They suggest that the novice designer is able to work from the very beginning of other project across several domains at once after gaining experience from several projects. If it is possible to make explicit design knowledge gained through designing, then design would be more accessible and there would be better chance for developing a better instructional methods or systems to assist design.

It seems that the creative process starts from some given thinking blocks (Johnson-Laird, 1988) or from something old, though it may belong to a related but different domain (Weisberg, 1992). Since few design problems require completely novel creativity without previous knowledge or experience, the designer should familiarise himself with the design knowledge, solutions to previous problems, or the ideas of others such as design style (Simon, 1975; Akin, 1986; Chan, 1990) . It would help him to design creatively.

The influence of design knowledge or experience on creativity shows two sides of the same coin. On the one hand, the inexperienced designer, with his naively and lack of experience, can often be more creative than the more experienced designer. The fact that he does not have preconceived ideas or the previous knowledge in traditional context can give him a chance to make a genuine invention. However, in the worst case, he would find that his design is full of mistakes which cannot be accomplished at all. On the other hand, design knowledge or experience

could be a reservoir for creative design because some believe that design has to start from somewhere. Many possible solutions of the given problem emerge from the reservoir. However, prior knowledge or experience can have the effects of mechanising thought and limiting ideas.

2.5 Design as problem solving

Design problems are not like scientific, mathematical, or logical problem which generally require the 'proof' of a hypothesis. They are not like crossword puzzles or guessing games, which have a single correct answer. They are not like the problems of an artist or a composer, who works principally to satisfy self-imposed goals and standards. Design problems often contain aspects of all these other types of problems, whilst remaining distinct (Cross, 1977: 140). Therefore, to design is to tackle a unique type of problem.

It has been identified that each designer has his own design process which he explores and develops through his design work. The designer treats a unique design problem through a unique design process based on his own design knowledge. He interprets the design situation in his own way. In this sense, Cross (1977) considers design as a sort of problem solving

The idea of looking at design as a type of problem-solving is not new. The idea has started since the 1960s as Heath (1984) pointed out, during the 1960s, Reyner Banham described design as problem solving and criticised architects for not having shown themselves to be universal problem solvers. Although designing using this approach is not the absolute way of understanding the nature of design, it is one of the widely accepted ones. The notion of systematic methods of design has introduced the concept of problem solving for the assessment of design problems and the development of design solutions.

The word 'problem' in design remains a difficult one to define. It is just like the word 'design' whereby too many definitions and derivations associated with it. According to Newell and Simon (1972), who have played a decisive role in the development of this subject, define a problem as follows:

“A person is confronted with a problem when he wants something and does not know immediately what series of actions he can perform to get it” (Newell and Simon, 1972: 72).

Their idea is that problems can be understood by reducing them to their anatomical parts. According to this view, a problem can be thought of as having a starting or 'initial state' and a final or 'goal state'. All of the possible solution paths from the initial state to the goal state comprise the 'problem space'. In solving a problem, people search through the problem space to find the best path from the initial state to the goal.

In architectural design problems, a distinction can be made between those that are '*well structured*' and those that are '*ill structured*'. Well-structured problems are those for which the goals and criteria for testing any proposed solution are already known and one has to find the means (Rowe, 1987). Rittel and Webber (1972) refer to them as '*tame*' or '*benign*' in which all the necessary information for solving them can be stated. Systematic approach of the design process is included in this category. For ill-structured problems, on the other hand, both the goals and the means of the solution are unknown at first and the designer has to define the problem. Many design problems which are ill structured can also be called '*wicked problems*' in that they have no definitive formulation, no explicit stopping rule, always more than one plausible explanation, a problem formulation that corresponds to a solution and vice versa, and that their solutions cannot be strictly correct or false (Rittel and Webber, 1972). Nevertheless, Simon (1973) argues that there is no clear boundary between '*well-structured*' and '*ill-structured*' problems. He considers how the conventional problem solving processes can successfully tackle ill-structured problems by working on some well-structured sub-problems at any given moment despite the difficulties of decomposing them. Nevertheless, this doesn't constitute the necessary and sufficient conditions. Many researchers pointed out what differentiate architectural design problem-solving from general problem-solving.

Among many efforts to consider design as problem solving, (Rowe, 1987) : 56) divides problem solving behaviour into three subclasses of activity :

1. The problem representation which represents the problem through structuring and restructuring a problem space;
2. The solution generation which generates solutions; and
3. The solution evaluation which evaluates candidate solutions.

Lawson (1990), distinguishes the characteristics of design problem solving, design solutions and the design process as follows:

Regarding design problems, they cannot be comprehensively stated. They are full of uncertainties in both about the objectives and the priorities which most of the time affecting the designer in making decision. In fact, according to Lawson, “both objectives and priorities are quite likely to change during the design process as the solution implications begin to emerge”.

On the part of interpretation of the problem, they can be very subjective. Designers from different fields could suggest different solutions to the same problem. In fact not only the solutions most of the time the problems are also perceived differently. Thus, for this matter, Lawson concluded that design problem like the solutions remain a matter of subjective interpretation.

Another important characteristic of design problem is that there is no objective or logical way of determining the level to tackle the problem. Because these problems need pragmatic decision, they depend on the situation and tend to be organised hierarchically.

Regarding design solution there are at least two characteristics distinguishing them. First, since design problem cannot be comprehensively stated, there are an inexhaustible number of different solutions to a problem. However, according to Lawson (1990) if we accept that design problems are rather more unexplainable and ill-defined, then it seems unreasonable to expect all the design solutions to a problem have been identified. Second, there is no optimal solutions to a design problems. He added that “design solutions can never be perfect and are often more easily criticised than created”.

On the characteristics of design process, there are at least six factors associated with it. For quick illustration we list them as follows:

1. The process is endless.
2. There is no infallibly correct process.
3. The process involves finding as well as solving problems.
4. Design inevitably involves subjective value judgement.
5. Design is a prescriptive activity.
6. Designers work in the context of a need for action.”

Although design is not pure goal-directed problem solving, the problem solving approach proves to be one of the most appropriate means for understanding the nature of the design and the design process.

2.6 Design as communication

Communication is fundamental in design. The professional roles and functions of designers are linked to the social context in which they practise. Nelson (1979) points out that every design is in some sense a social communication, and what matters is the emotional intensity with which the essentials have been explored and expressed. Thus the design process should be considered as a response to changes in the wider social and cultural context in which design is practised as well as the result of careful and wilful planning.

Design as communication is viewed by (Osborne, 1969) as languages which communicate with the society. He says:

“Man builds **shelter** for its protection, but as he extends his skills in building he begins to create a language of form which, as he develops it, becomes capable of touching the emotions, producing delight, surprise, wonders or horror. At this level a building not only **fulfills as a practical purpose but communicates**. The ability to relate these two is called Architecture “(Osborne, 1969)

Meanwhile, Baker (1989) sees communication in building in many ways; as a form of signal giving for certain practical purpose, portraying symbols for certain definite activities and so on. In analysing Monastic Complex at Assisi, he says:

“The campanile acts as a beacon, proclaiming the nature of the activities taking place within the complex. A porch defines the entry point to the lower church. The approaches from the town follow the contours at different levels” (Baker, 1989: 96)

and,

“The two piazza divide the town from the monastery, a complete symbolic break between secular and holy ground. The piazza enable a full appreciation of the position of the buildings in the landscape, whilst the facade and campanile signify the religious identity of the complex” (Baker, 1989: 97)

The division of labour between those who design and those who make has now become a keystone of our technological society (Lawson, 1990: 15). This separation sets design as a distinct abstract process removed from the construction of the products. Early efforts of design methodologies concentrated on the act of designers considering designers as experts who know the best. It is the second generation of design methodologies that begins to reconsider the importance of the

social context in design. This generation especially emphasises communication between users and designers. However, in general, two approaches, scientific and psychological, for understanding the nature of design scarcely mentioned such issues.

2.7 Construction technology in architectural curriculum

It is not argued here that design should not form the backbone of the architectural curriculum. This generic model seems reasonable and workable in architectural education. But what is sorely needed is a new fresh look at the way in which design is linked with other courses - in particular construction technology. As Wolf (1987) emphasised that as built '*constructed*' art, architecture must be based on the tectonics of the joints on a heightened sense of relationship with the elements. Indeed as built art construction becomes an important ingredient of design and should be regarded as an essential part of its practical as well as aesthetic vocabulary.

In another view, Reno (1992) explains that the act of construction is an expression of an innate curiosity to assemble elements in a logical order. Her analogy is based on a toddler playing for hours with any combination of objects or puzzle to understand the world of things. In relating this to the learning of construction technology in the architectural education, she criticised that the understanding of this subject (construction assemblies and properties of materials) is relegated to *knowledge by description* whereby they are assigned to the standard details and wall sections of reference books. In supporting the integration of construction technology teaching with design she says:

“Materials, however, are the media of architecture. Because the properties of materials, alone and in combination, are basic to design, an education in building technology must attempt to integrate design and construction for the students” (Reno, 1992:161) .

In her paper, she proposed a learning concept for the architectural students using the *Chernikhov's Constructivist Rules*² to provide the structure for a *design-build* pedagogy. Her proposal is addressed both to the formal and compositional which is the design aspect, and the technical and constructional - the assembling of materials which is the build aspect. Like a play, this concept which proposed a methodology provides a creative synthesis of logic and fantasy but associated with real objects. What can we learn from this concept as stated by Judith are as follows:

² Constructivism is a concept related to any compact combination of different objects capable of being brought together into a single unified entity. Please refer to (Reno, 1992) page 191

1. The desire to have constructive links between component parts
2. The pursuit of consistency in the combining of elements
3. The demand for meaningfulness in the combination
4. The logical generation of form
5. Cogency and persuasiveness and
6. A reaction of influence on the viewer

The intent of Chernikhov's Constructivism is to enable the combination of all types of different objects into a single unified entity.

While the above study projects prove to be workable, other experiments carried by Allen (1980), Newman (1978) and Vestuti (1993) open up another perspective of teaching/learning construction technology. These three researchers among others agree on a common issue that is the fusion of experience or hands-on experience for an effective learning approach. Allen (1980), criticised the typical architectural training whereby according to him the students are isolated while trying to solve the design problems (construction problem) and guessing the solutions on paper. He suggested constructing and testing the materials in the laboratory is the appropriate way to gain understanding and confidence in construction technology. He strongly believed in this method of teaching construction technology and to him the studio offers the best open laboratory setting.

“For students of architecture, a laboratory can be the most natural and productive way of learning about building construction. Construction is a highly tactile art, produced by people's hands and often best appreciated through the sense of touch.” (Allen, 1980: 22)

A similar methodology was carried out by Vestuti (1993) with her first year students. Vestuti believes that there is a great measure to the distance between the architect (student) and the actual building process and because of this, according to her, qualities are often missing in architecture today. To reduce this gap, she proposed and experimented various design projects especially for the first year which involves the actual building process; in this case, she proposed the '*furniture*' or other '*micro-structures*' objects (such as lamps). Despite the projects being considered small-scale, they constitute valuable learning experiences. On the aspect of learning and motivation she says: “The design/build method provides a format, which in itself, is stimulating and motivating - a welcome change of pace from the usual '*paper*' design problem.”

The review suggests that hands-on experience is appropriate as a teaching tool in construction technology

While there are many setbacks like problems of space and fund-limitation especially in reference to the schools in Malaysia, we look into another view of learning construction technology. Newman (1978) too believes in hands-on experience but added another important aspect of design while learning construction - social awareness and sensitivity towards the environment which actually involve the students right from drawing board to the actual constructing the building. The benefits seem exceptionally encouraging when he says:

“For the students, the building becomes a laboratory of learning, where they can experience the many levels of architecture, discover how a building is used, and test their design by user reaction”(Newman 1978: 27)

The project seems to benefit both the students and the clients. On the aspects of understanding materials of construction he says:

“... it is refreshing to participate in and observe exploration and struggle with the building blocks of architecture: the materials and methods of construction which release students from their pre-conceived academic or historical references on the one hand and their rush to the feet of their avant-garde heroes on the other.”
(Newman, 1978: 28)

Although this program has been established for quite some time and proves beneficial for the clients and considered a significant experience for the students especially the first year students (Newman, 1978: 27), it is quite disappointing from the review that the architecture school in Yale University is the only University in the United states that require such program. Many reasons could possibly explain this situation - timing is difficult, lack of funding, lack of appropriate domestic sites to carry out such activities and most likely lack of experienced and capable builders to assist the program. In the case of architectural schools in Malaysia, most of the time they are replaced by short courses site visits.

2.7.1 Learning construction technology - the problems

Whilst it is admitted here that such an innovative teaching method convincing to be workable in some ways or another, it is, nevertheless, noticed that most architectural schools in Malaysia today not only tend to have an emphasis on “design” course but rather prefer to follow the conventional teaching methods. Consequently, it results in the relegation of practical courses such as construction into a secondary level. In turn, this has resulted in lack of innovation, motivation and it

poses problems in learning construction technology. Among other reasons partly to be blamed are:

1. **Preference for superficial form**

The preference for superficial form over the constructional integrity is taking precedence in our society. Thus, the teaching of the subject is being dominated by the forms and spaces rather than the true works of its construction.

2. **One-dimensionally literal use of reference**

The attempts to recreate a '*sense of place*', or sometimes referred to as the '*identity*', through application of historical and regional motifs into the building usually fail because of the superficial use of them as termed by Juhani Pallasmaa (1988) in his review on the tradition and modern architecture, as "the one-dimensionally literal use of reference". In this case, culture is taken as an object and the past is taken as a source from which to select instead of being the profile and context of creative work.

3. **Craftsman builders**

Traditional buildings are very much appreciated by most people because these buildings are built by builders that are craftsmen themselves, who not only build but also understand how the building is being constructed and at the same time understand the philosophical theories behind each building built. However, new architects tend to concentrate more on the theoretical aspect of the buildings and not the means.

4. **Conventional thinking**

The society is becoming conservative in matters of building technology and is reluctant to try new products i.e. construction materials and methods. The main reason for this is the increase in tendency to have disputes in courts in cases of damage or failure.(Peters, T. F, 1986). This also applies to the Malaysian context. This will affect the new venture in the teaching of construction in the school of architecture.

5. **Construction teaching is factual and mechanical**

The teaching of construction is not geared towards lateral thinking. It is more concentrated on the factual and mechanical aspects such as the detailing of building sections, load calculation and the normal method of arranging

building elements in place described earlier in section 2.7 as *knowledge by description*. The long list of the syllabus needed to be covered in the lecture room is partly to be blamed. There is no question of "Why not ?" along the course.

6. Large amounts of complex technical knowledge

Construction related education requires the accumulation of large amounts of complex technical knowledge by students. The acquisition of these knowledge has to be organised properly to ensure that the learning process is not simply based on mass transferring of technical information. Because of this, the conventional methods of teaching which largely depends on conventional lectures are greatly affected. Consequently, delivery of this large amount of information needed to be channelled properly and using more innovative methods depending on the learning requirement and context.

2.7.2 Acquisition of construction knowledge

So far we have analysed the issues and problems related to the understanding and delivery of construction technology information. The acquisition of this knowledge has to be organised properly to ensure that the learning process was not simply based on mass transfers of technical information, but on the prescribed learning objectives of the subject content. Referring to the syllabus outline of teaching construction technology in the architectural school in Malaysia (Sub-Committee, 1994; Universiti Sains Malaysia, 1994; Institut Teknologi MARA, 1995a) , summarised the main intentions of teaching construction technology which should be for:

1. A student to understand the relationship between the design and the technical aspect of a proposed design
2. Stimulating interests and providing the possibilities in creating new ideas evolving through technology.

Consequently, delivering the large amount of information needed to be channelled properly through a variety of media largely depends on the learning requirement and context. For example, students find it difficult to visualise construction assemblies by means of two-dimensional (2D) plan, section and elevation only. A three-dimensional (3D) model representation that may be rotated to

be viewed from all angles, disassembled or exploded to show its parts is far more meaningful to the students.

A similar example will be in the learning of building materials. In this example students are expected to understand the various technical procedures and characteristics of that material which are vital in their final selection of building materials and finishes. This poses problems to the school if we only rely on conventional lecturing method. In order to make the students understand these characteristics, some kind of simulations are strongly recommended. This kind of visual aids not only help students to understand the workability of the materials but making it more enjoyable for them to learn.

A report from Architectural Record dated June 1985, on the issues of integration of construction, practice and computers in architectural education, which states that many researchers and educators strongly believe in the integration of construction *with* designing process. Among them are (Lawson, 1975; Allen, 1980; Reid, 1984; Ledewitz, 1985; Levy, 1985; McSheffrey, 1985; Khan, 1987; Burnham, 1988; Buchanan, 1989; Fowles, 1990; Lawson and Roberts, 1991; Reno, 1992; Fethi, Mahadin et al., 1993; Harfmann, 1993; Lawson, 1993; Ballal, 1997; Riley and Hodgkinson, 1997) among others make a strong stand towards the integration of construction with design process. In order to achieve this, we believed that teaching principles of construction technology is fundamental to the design process. A clear distinction between teaching construction principles and making construction (construction documentation) should be clearly understood by lecturers:

“However, it is important to draw a clear distinction between teaching construction principles and making construction or working drawings. Construction principles, it must be emphasised, are an essential basic ingredient of what we call the ‘*design*’ process.” (McSheffrey, 1985: 1)

He further emphasised that construction process is a supportive function of and ancillary to the design process.

“It is my contention that construction is part of and essential to the design process; and without it, the design process make no sense except in the abstract, since it deals only with limited issues and can never be realised without the means - construction.” (McSheffrey, 1985: 2)

2.8 Computer-aided-learning (CAL) in the architectural education

Computers have entered education in a big way. The potential of computing in architecture can be seen in many ways, in the design studio as well as in teaching architecture related subjects (Bridges, 1993). However, in architectural training much of it is associated with the production of graphic images. Computer Aided Design or Drafting (CAD) has been recognised as an important tool for the architectural students to communicate their design ideas through beautiful perspective drawings but the corresponding increase in the use of information technology (IT) to supplement teaching and learning functions is not as yet obvious. The use of computers in assisting teaching/learning especially in the role that it plays in the design process is viewed with some scepticism (Abu Bakar, 1992).

Literature on teaching and learning, however, reveals that many have tried to solve the problems of matching learning and teaching by the use of computer technology. In the use of multimedia applications, for example, De Bloois (1987) and Carlson and Falk (1991) summarised a variety of literature which pointed to the benefits of instruction centred around interactive video for education and training. According to Falk and Carlson (Falk and Carlson, 1995), this has led to greater learner satisfaction. It also claimed to have the advantage of being able to match the student's learning style.

CAL is seen to be particularly attractive to simulate technological activity and to bring real contexts into the learning activity. It has been projected as being the solution to problems facing teaching at many levels. CAL is considered an alternative to mass education and a response to its problems of large classes and limited time for individual instruction. It has the advantage of achieving the great educational ideal of allowing each student to proceed at his own pace on the learning process. Although many problems and failures have been identified on CAL especially on programmed learning in the past years, recent developments in hypertext and hypermedia technology and '*flexible learning methods*' have made it possible to take advantage of powerful computers to assimilate knowledge to learners (Abbas, MacCallum et al., 1995). Such developments suggest that CAL may be a particularly appropriate means of supporting design and technology work.

Many learning support have been successfully developed not only for lower aged learning (i.e. school children) but also for professional studies such as medicine (Paterson and Adamson, 1992); law (Gibbons, 1992); chemistry (Long, Pence et al., 1995; Wilson and Cavallari, 1995) and architecture (Lawson, 1971; Lawson and Roberts, 1991; Bridges, 1993; Lawrence, 1993). Some of the examples of case

studies on CAL specifically for construction technology learning in architectural education are illustrated below:

Riley and Hodgkinson (Riley and Hodgkinson, 1997) used the application on multimedia to illustrate the principles of building system in a form of animated graphics. One of the elements that they considered in the program is the effects of various forms of loading on buildings such as the effect of wind-induced lateral loading on the structure of a building. The illustrations are shown in **Figure 3(f)**.

The aim of the package (which is still at prototype stage) is to create situations which would demonstrate the principles of building system. The package gives the user the option to consider building elements or components as graphics, drawings or photographs, and it also permits various levels of interrogation. As students have different learning levels, the package allows them to investigate and learn at their own pace. During the limited trial 150 students (from The School of Built Environment, Liverpool John Moores University) were exposed to the program in a variety of situations. Feedback was gathered from these students. The benefit of the package seemed to be on the flexibility of application and was seen as a valuable aid to teaching and learning in the classroom as well as an effective self-directed tool for open learning.

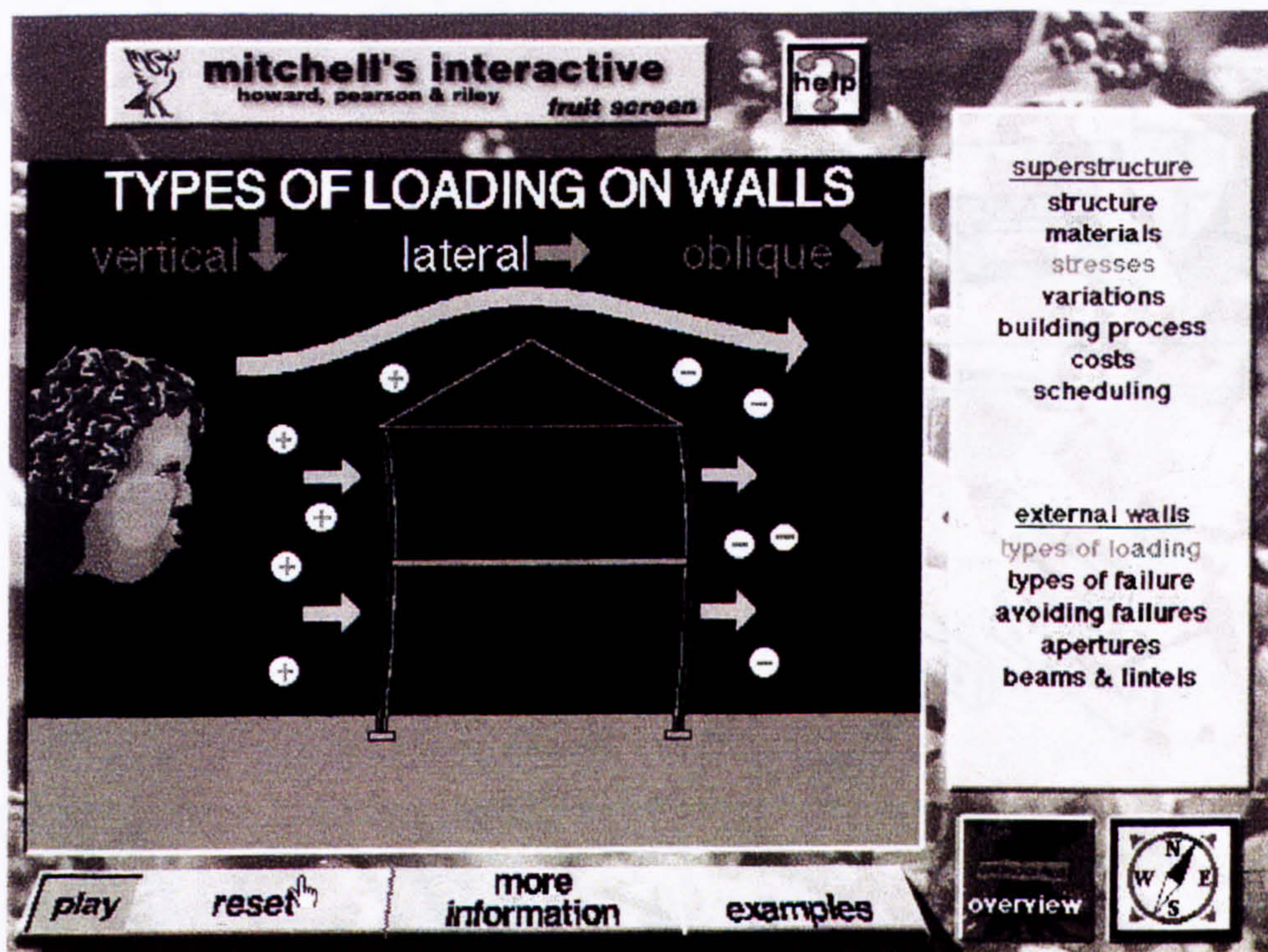


Figure 3(f). Example of screen and control panel - showing a giant head blowing at the house illustrates the wind source (Riley and Hodgkinson, 1997: 2)

Harfmann (1993) in his paper presented in ACADIA 1993, presented an interesting approach of CAL in the learning of construction technology. Computer technology was used in communicating technical information about a building to a more accurate three dimensional computer modeling. The system was able to present a three dimensional model of building components for the production of technical drawings. In this system, the entire building, including the mechanical, electrical and plumbing systems would be entirely designed and integrated into the three dimensional computer modeling utilising individual component-level representation. The illustrations are shown in Figure 3(g).

The system, in other words, will be able to do a three dimensional model of working drawings (using the standard sections, layers, views, etc.) By doing this, the information about building components, dimensions, joints and assemblies will be clear and easy to understand by any parties of the building design team. The major benefits of this technique are derived from its three-dimensionally approach and enhancing visualisation in technical communication. According to report the system is immensely useful for the practicing architect. Additionally, it offers valuable applications in architectural training.

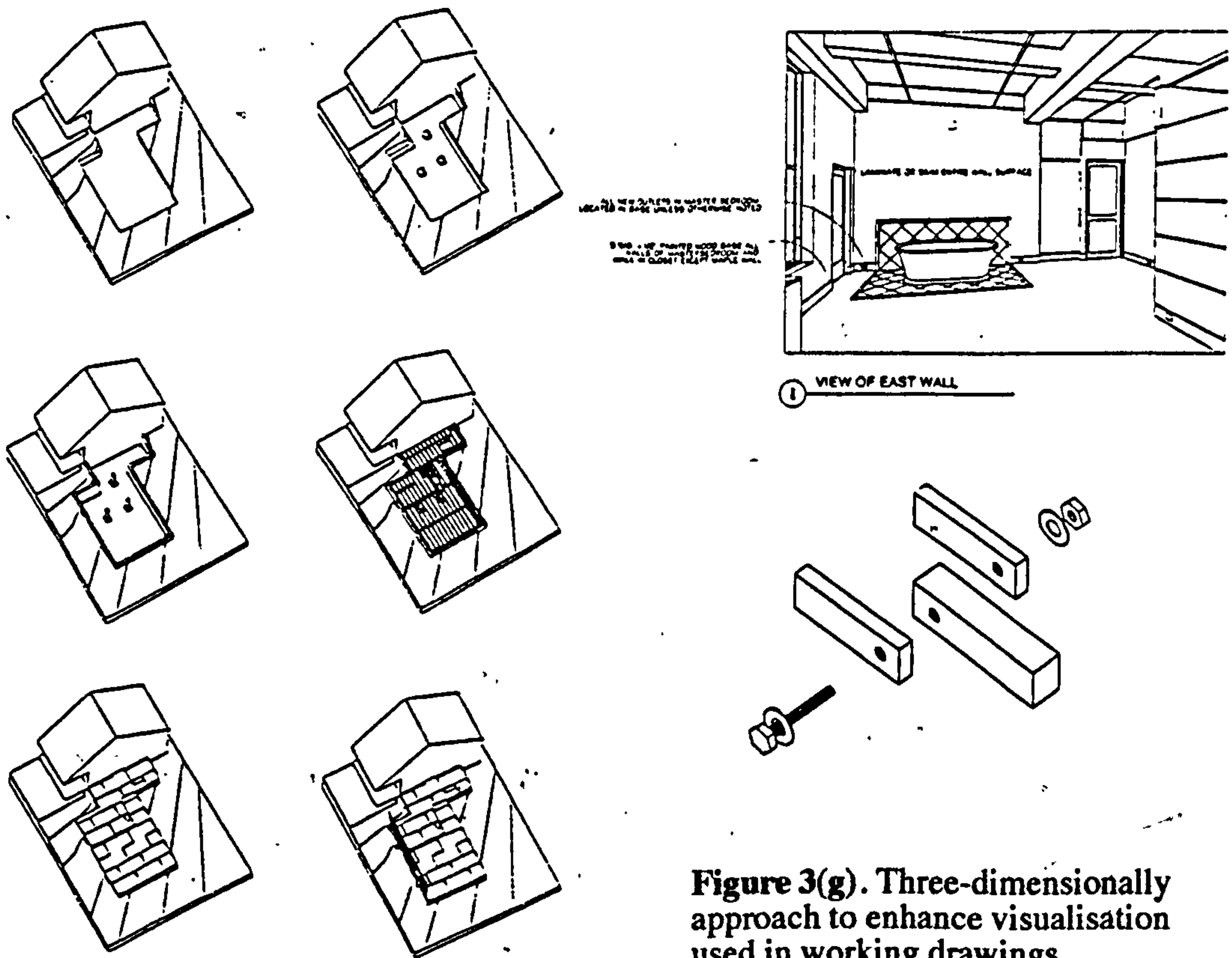


Figure 3(g). Three-dimensionally approach to enhance visualisation used in working drawings (Harfmann, 1993: 143, 149)

Therefore, computer technology especially with the more advanced multimedia system that is available in the market nowadays is positively aiding the comprehension of construction technology. Through its simulations theory and its practical applications, computers greatly help the understanding of construction technology.

The computer has great capacity to simulate cause and effect, particularly when their interaction can be defined mathematically. The simulation of a change in structural load by interacting with the machine on the building components in (Riley and Hodgkinson, 1997) or the three dimensional visualisation on intricate construction detailing can be an effective help to the learning and understanding of the construction principles involved in designing a building.

In the CAL system, real learning situation and context can be brought into the learning environment. A good example of this could be seen in the second case study. Here, problems were presented through the screen and the student-participant ventured to solve the problems using the computer. This method not only simulates real life situations, it also manages to record the various site activities in a format readily accessible to all students at all times. Immediate feedback is assured and this contributes to rapid decision making.

The nature of certain design projects may require students to seek information outside the range of the specified subject matter. Traditionally, the acquisition of such information is very difficult. Students might need to acquire information through means such as by writings, library search or by actually going to the specific area needed. However, CAL applications can be used to support these requirements through links with the information search storage through the internet.

These examples lean towards the use of flexible learning methods. Although *flexible learning* is often associated with the *open university's distance learning programs* (Ellington, Percival et al., 1993) . The software packages will allow the teacher to use them as a learning support and more importantly, it gives the learner the opportunity to work at his own pace, in his own learning style and at his level of understanding. As illustrated in the example, the package will not at any circumstance replace lectures. It is just a learning supplement for the students.

“Computers have a limited role to play in teaching but a major role in support of learning” (Darby, 1992: 2)

A wide range of information and activities can be provided by CAL and it allows the freedom of an individual learning route.

Computer aided instruction is gaining acceptance in architectural education. However, the fundamental issues of learning such as appropriate materials and basic requirements of learners have yet to be addressed by software makers. Lecturers, meanwhile, seem to view this type of instruction with scepticism and caution and it is true that some teachers have not embraced this information revolution and that they are unwilling to give up their old ways because of fear and lack of inertia. Sadly, some faculty members are reluctant to take advantage of these new interactive learning tools which can greatly contribute to architectural learning. These issues will be investigated in the next chapter.

2.9 Summary

Throughout the review of architectural design, in general, design can be considered as a skill which can be learnt and practised. Everybody has the ability to develop this skill. However, there is no single universal process to be forced. It seems each of us must find our own methodology and learn how to adapt it to new design problems and situations. Thus every design methodologies and descriptions described in this chapter cannot be considered as completely right or wrong. They have some strong points as well as shortcomings. It is the designer who finds proper way of designing on his own. Efforts to understand design should be considered as a guide to lead the designer to find his own way of designing.

The above explanation about design, although incomplete, gives us an understanding about design from at least three perspectives: **First**, design as problem-solving, **second**, design as creative-thinking and **third**, design as communication. Despite described separately, they should be understood holistically. For example, a problem-solving activity in design is very much dependent on how creative a designer think about the problems and methodologies of solving them and these ideas are also closely related to how well the designer sees or communicates with the problem in relating them to the end user, the environment and other conditions like culture, religion symbolism and so on. All these factors are inter-link in design.

On the part of construction technology, we agree that the construction process is the supportive function of a design. Without the means (construction technology) the design process will not be transformed into buildable forms. Throughout the review on construction technology learning, there are at least two aspects of learning construction technology are worth being mentioned here; **first**, construction technology is both factual and very technical and **second**, construction technology learning needs experience-based learning or training.

All the methodologies reviewed strongly hold the principle of learning construction technology as part of the whole design and not the other way round.

Chapter 3

Teaching and Learning Methods in Architectural Education: A Malaysian Case Study

3.0 Introduction

A review of literature reveals that no empirical work has been conducted in the aspect of architectural teaching and learning in Malaysia. Background information is furnished to familiarise the reader with the higher learning environment in Malaysia in general and the architectural school under investigation in particular. As an introduction, the chapter reviews the general aspects of teaching and learning. It will later relate them to the architectural education in Malaysia. The chapter is divided into six sections namely:

1. Understanding Teaching and Learning
2. Higher Education in Malaysia
3. Architectural Schools in Malaysia
4. Training Programme
5. Teaching Methods Used
6. Learning and teaching methods: A methodological mismatched

3.1 Understanding teaching and learning

It is essential to look at what most educational psychologists say about the meaning of teaching in reference to concept, experience, readiness and orientation to learning. Clayton (1968) outlined in general the function of teaching as communication. It consists largely of the communication of information and opinions

from the *teacher* , the disseminator of information, to the student/s, the receivers of knowledge. According to him:

"Teaching can be described as an activity in which a teacher, aided by various material resources, initiates students into the mastery of selected knowledge, skills and attitudes."

According to Knowles (1970), teachers have their own principles of teaching such as the professional knowledge of the subject, the techniques or style (commonly called the teacher's personality) and the expected behaviour of the class. We can include all the aspects of teaching into the term '*pedagogy*'. The generic definition of the word '*pedagogy*' (Knowles, 1970) actually refers to a term derived from the Greek words 'paid' (meaning child) and 'agogus' (meaning leading). So the word '*pedagogy*' means literally, '**the art and science of teaching children**'. The pedagogical assumptions about teaching were therefore based on telling something or teaching something that is right or wrong.

On the other hand, there exist another theory relating to teaching called '*andragogy*'. This theory emerged into the discussion of teaching models during the 1950s when the pedagogical model was being questioned in the Journal of Adult Education, published by the American Association for Adult Education between 1929 and 1948 (Knowles, 1970). In this article issues on the differential models of teaching adult from the children were being brought out and the word pedagogy, were on the other hand being questioned. As a result, a new teaching model known as '*andragogy*' emerged. The word is derived from the Greek word 'andr' meaning 'man or adult'. Therefore, the word '**andragogy**' literally means '**the art and science of helping adult learn**', as opposed to pedagogy the art and science of teaching children (Knowles, 1970) .

3.1.1 Pedagogy and andragogy

The words pedagogy and andragogy are not crucial; it is the concept behind the term which is important that is the concept of higher learning of the children or the adult - the higher education. For further understanding of the concepts behind these two models of teaching and learning, it is appropriate at this juncture, for the researcher to compare the assumptions of pedagogy and andragogy on learning criteria as laid down by Knowles (1970).

Table 3.1:
Knowles 's comparison on the assumptions of pedagogy and andragogy.

	PEDAGOGY	ANDRAGOGY
1. Concept of the learner	The role of the learner is, by definition, a dependent learner . The teacher is expected by society to take full responsibility for determining what is to be learned, when it is to be learned, how it is to be learned and if it has been learned	It is a normal aspect of the process of maturation for a person to move from dependency towards increasing self-directness , but at different rates for different people and in different dimensions of life. Teachers have a responsibility to encourage and nurture this movement. Adults learner have a deep psychological need to be generally self-directing, although they may be dependent in particular temporary situations.
2. Role of learners' experience	The experience learners bring to a learning situation is of little worth. It may be used as a starting point, but the experience from which learners will gain the most is that of the teacher, the textbook writer, the audiovisual aid producer, and other experts. Accordingly, the primary techniques in education are transmittal techniques - lecture, assigned reading, audio visual presentation	As people grow and develop, they accumulate an increasing reservoir of experience that becomes an increasingly rich resource for learning - for themselves and for others. Furthermore, people attached more meaning to learning they gain from experience than those they acquire passively. Accordingly, the primary techniques in education are experiential techniques - laboratory experiments, discussion, problem-solving cases, simulation exercises, field experience, and the like.
3. Readiness to learn	People are ready to learn whatever society (especially the school) says they ought to learn, provided the pressures on them (like fear of failure) are great enough. Most people of the same age are ready to learn the same things. Therefore learning should be organised into a fairly standardised curriculum, with a uniform step-by-step progression for all learners.	People become ready to learn something when they experience a need to learn it in order to cope more satisfactorily with real-life tasks or problems. The educator has a responsibility to create conditions and provide tools and procedures for helping learners discover their "needs to know" . Learning program should be organised around life-application categories and sequenced according to the learners' readiness to learn.

	PEDAGOGY	ANDRAGOGY
4. Orientation to learning.	Learners see education as a process of acquiring subject matter content, most of which they understand will be useful only at a later time in life. Accordingly, the curriculum should be organised into subject-matter units (e.g. courses) which follow the logic of the subject (e.g., from ancient to modern history, from simple to complex mathematics or science). People are subject-centered in their orientation to learning.	Learners see education as a process of developing increased competence to achieve their full potential in life. They want to be able to apply whatever knowledge and skill they gain today to living more effectively tomorrow. Accordingly, learning experiences should be organised around competency -development categories. People are performance-centered in their orientation to learning.

(Source: The Modern Practice of Adult Education by (Knowles, 1970. pp. 43-44.)

3.1.2 Student-centered learning

Learning in higher education is in the main student-centered rather than teacher-centered. Psychologists like Carl Rogers, conceptualised a theory about adult learning based on the 'client-centered therapy'³ (Rogers, 1951) He put forth the basic hypothesis of this theory into 'student-centered learning' which are:

1. We cannot teach anyone directly; we can only facilitate a person's learning.
2. A person learns significantly only those things which are perceived as applicable in the maintenance or enhancement of the structure of self
3. If an experience involves a change in the organisation of the self, learners are likely to resist it. A person's boundaries tend to become rigid when threatened, relaxed when free from threat.
4. Any experience perceived as inconsistent with the self can only be assimilated if the current organisation of self is relaxed and expanded to include it.
5. The educational situation that most effectively promotes significant learning is

³ Rogers, (1951)pp. 388-391. See also Rogers (1969) and (1986)

one in which threat to the self learner is reduced to a minimum.

Rogers, then suggested the shift of the spotlight from teacher to individual learners. He also advocates delineation of accountability so that teacher and learner become jointly responsible for a positive outcome.

Meanwhile, Waugh (1974) in his series of books on student-centered learning expressed good teaching as a love affair between the teacher, his subject, and his students in which each participant must contribute to the growth of knowledge. The implication is that the essence of good teaching is a close relationship between the subject, the student and the teacher. The three-way relationship, thus, becomes one involving complex and partly dependent variables. Each derives some benefit from the other two. Figure 3(a) below illustrates this relationship.

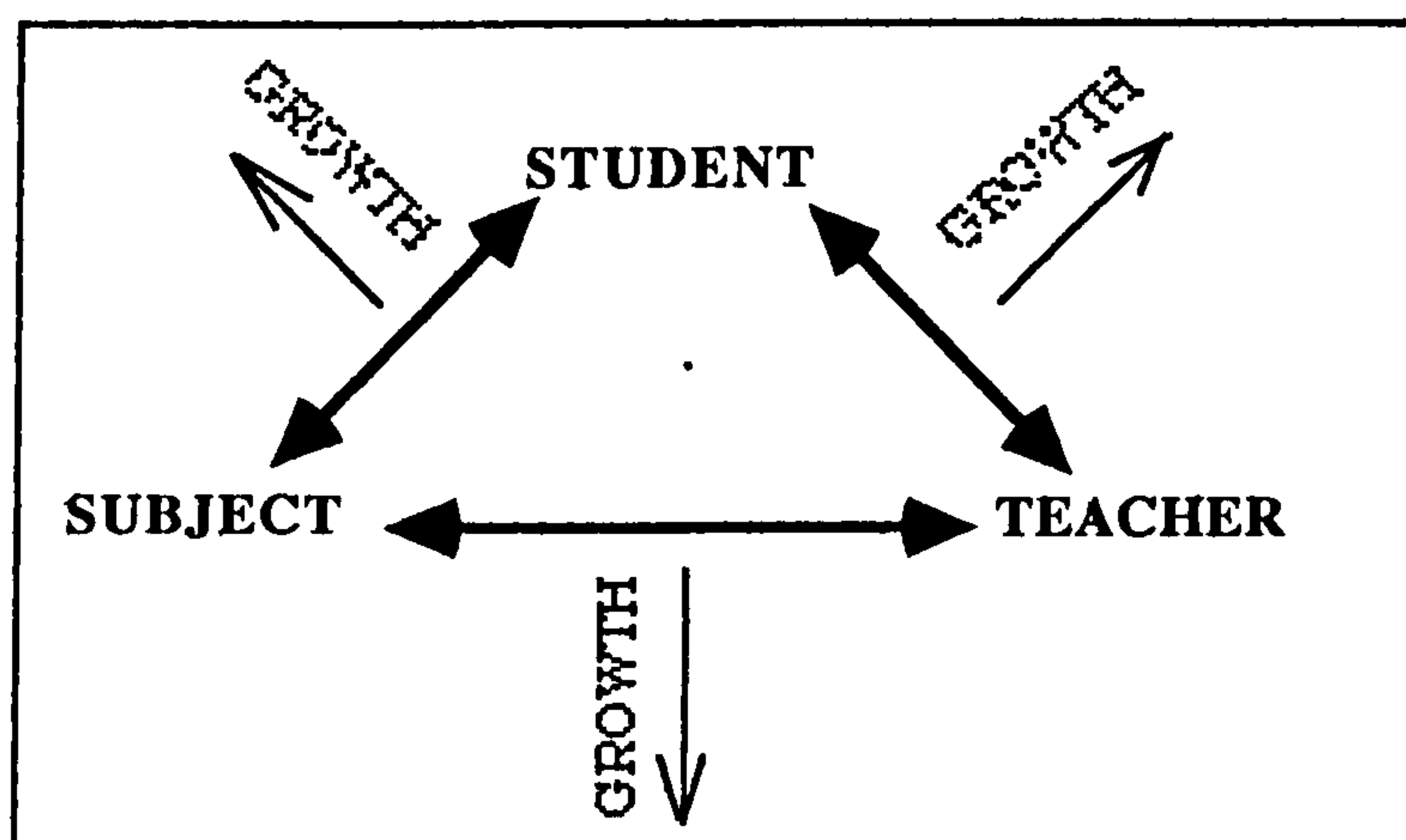


Figure 3.1. Relationship of student-subject-teacher
(Source: Waugh (1974: 134))

1. Teacher-subject relationship

Waugh believed that the teacher should have a close relationship to his subject which means that he has to know the subject very well and should be an active participant in its evolution (the growth). He must also have a good understanding about his students in the sense that he should allow space for students to approach him or even ask for feedback about the subject. In other words, the teacher must be

prepared to accept criticism positively as well as praise.

2. Student-subject relationship

The interaction between student and subject sometimes does not exist. In this case the teacher plays an important part. The function of the teacher is to create interest to the subject which will motivate students to learn. An example given by (Waugh, 1974) is the use of practical classes or experience learning which could promote interest to the subject. By doing that, students not only understand the subject matter, they can also apply it to other situations.

3. Student-teacher relationship

The student-teacher relationship is no doubt a very important relationship in the educational process. In general, a student comes to an educational institution with certain hopes and expectations. He comes to learn and expects the teacher to perform. The success of the educational process thus, depends greatly on the student-teacher relationship. To learn effectively, the student, in this case an adult student, also needs a teacher who knows and understand him. The teacher should, therefore, understand the student's background and his academic experience to make the learning experience a fruitful one (Renner, 1994).

In the next section, the issues of learning and teaching in architectural education will be looked into with particular emphasis on Malaysia. Related issues such as background of institutions, educational objectives, structural organisation of the courses, professional training and experiences and methods of teaching/learning currently practiced in the different schools will be analysed. The analysis will help the researcher to have a first hand understanding of the problems faced by the architectural students in achieving positive performance in architecture.

3.2 Higher education in Malaysia: a brief description

3.2.1 Introduction

Education is a major sector of the Malaysian economy. Every year, the Federal Government spends large amounts of money on education. The allocation for education and training in the Seventh Plan amounts to RM. 10.1 billion or 15.4 per cent of the total public development allocation compared with 13 per cent in the Sixth Plan (this includes the allocation for building new schools, provision of training facilities and skill training), making it the highest amount spent by the Federal government on social services (Government Of Malaysia, 1996a). Higher Education in Malaysia comes under the Ministry of Education. Among its many tasks, the Ministry is responsible for drawing up the National Education Policy. The principles addressed in the policy are based on the National Ideology or the '*Rukunegara*'. As such, the National Educational Policy adheres to the country's aspiration of unity and development as identified in the '*Rukunegara*'. The Malaysian Educational policy for the 1990s thus states that:

"Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious, based on firm belief and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards, and who are responsible and capable of achieving a high level of personal well-being as well as being able to contribute to the harmony and betterment of the society and the nation at large"
(in Lim, 1994: 11)

A Research and Development Unit (R&D) was established to upgrade the quality of education. Its function is to investigate the problems of higher education and upgrading the research and development in the country. One of its objectives is to improve the learning/teaching methods in correlation with the expanding needs of the country. This is to prepare Malaysia to become the centre of higher learning in South East Asia by the year 2020⁴ (Government Of Malaysia, 1996a; Government Of Malaysia, 1996b).

Today, teaching in higher institutions is the object of both professional and public scrutiny. Three important reports, namely, Commonwealth Universities Year Book (1989); Commonwealth Universities Year Book (1991); Commonwealth

⁴ Under the Vision 2020 concept, Malaysia aspires to become a fully developed nation by the year 2020

Universities Year Book, (1993) have examined general aspects of teaching and learning in the higher institution in Malaysia. In the report teaching is described as an activity in which a teacher aided by various material resources, initiates the students into the mystery of **knowledge, skills and understanding**. In Malaysia, students are evolving into a more inquisitive and demanding nature. This is further accelerated by increasing usage of computers. The four elements of educational activity; teacher, communication resources, students and body of knowledge (Entwistle and Ramsden, 1983; Entwistle, 1990), are currently undergoing changes. The teacher is undergoing pressure of new generation students where the amount of knowledge possessed by students cannot be underestimated. They are full of potential that need to be guided in a fruitful direction. Malaysian teachers should be well prepared for this challenge. With the expansion of technology knowledge can be transmitted in various modes according to the needs and requirements of the learner. We believe that the rapid expansion of knowledge and the abundant communication resources should be treated as important assets to higher learning.

3.2.2 The aims of higher education learning in Malaysia.

Higher education in Malaysia is planned in the context of national development policies and needs. There are four main aims (Bahagian Perancangan dan Penyelidikan Pendidikan and Division, 1993; Razali, 1995) .

First, the overriding goal of the universities is to assist in the promotion of national integration and unity. It is hope that this will be achieved through the proper training of the teaching and non curricular programmes, through which the moral discipline would be gradually molded and national values inculcated.

Next, higher education should provide the opportunities to equip individuals with the appropriate knowledge and skills to meet the national human resource needs. This is the economic aim i.e. the need for higher education to meet national requirements and increase material prosperity.

For Malaysia this also means that the education system as well as the programmes of training have to be developed with an orientation towards a greater emphasis on science and technology. This is an extension of the economic aim since at the time of technological change a nation will need leaders and professionals to lead the

development of the nation to achieve '*Vision 2020*'. Vision 2020 is actually a set of objectives formulated by the current Prime Minister leading to Malaysia achieving the status of a developed nation.

The third aim of higher education is to advance the nation's learning. Malaysia has set many world class targets to be achieved by different institutions. To achieve these, a considerable body of knowledge has to be produced and one of the best places to do this is through institutions of higher learning. Malaysia realises the way forward is to master old and current knowledge and discover new ones. An intelligent notion makes for a leading nation.

Fourth, higher education functions as one of the mechanisms to forge the different ethnic groups into one Malaysian identity. This is indeed a lofty goal given the many different racial groups currently coexisting in a delicate balance. This ideal is a recent addition to the national ideal and its success remains to be seen. This is truly a formidable aim.

3.2.3 List of public higher institutions in Malaysia

Institutes of higher education consist of universities, institutes and colleges. The Higher Education Division functions as a secretariat which coordinates and monitors the activities of tertiary level education.

There are nine public universities (eight local universities and one international university), three private universities (not listed), one public institute and one public college in Malaysia providing undergraduate and post graduate studies. (The locations of all the universities, institute and college are shown in figure 3.2). They are:

1. The University of Malaya (UM)
2. National University of Malaysia (UKM)
3. University of Agriculture, Malaysia (UPM)
4. University of Science, Malaysia (USM)
5. University of Technology, Malaysia (UTM)
6. Universiti Utara Malaysia (UUM)
7. Universiti Malaysia Serawak (UMS)
8. Universiti Malaysia Sabah (UMS)
9. International Islamic University (IIU)

10. Universiti Petronas Malaysia (not listed)
11. Universiti Telekom Malaysia (not listed)
12. Universiti Tenaga Malaysia (not listed)

There are two college/institute offering semi-professional courses at certificate and diploma levels. They are:

1. MARA Institute of Teknologi (ITM)
2. Tunku Abdul Rahman College (TARC)

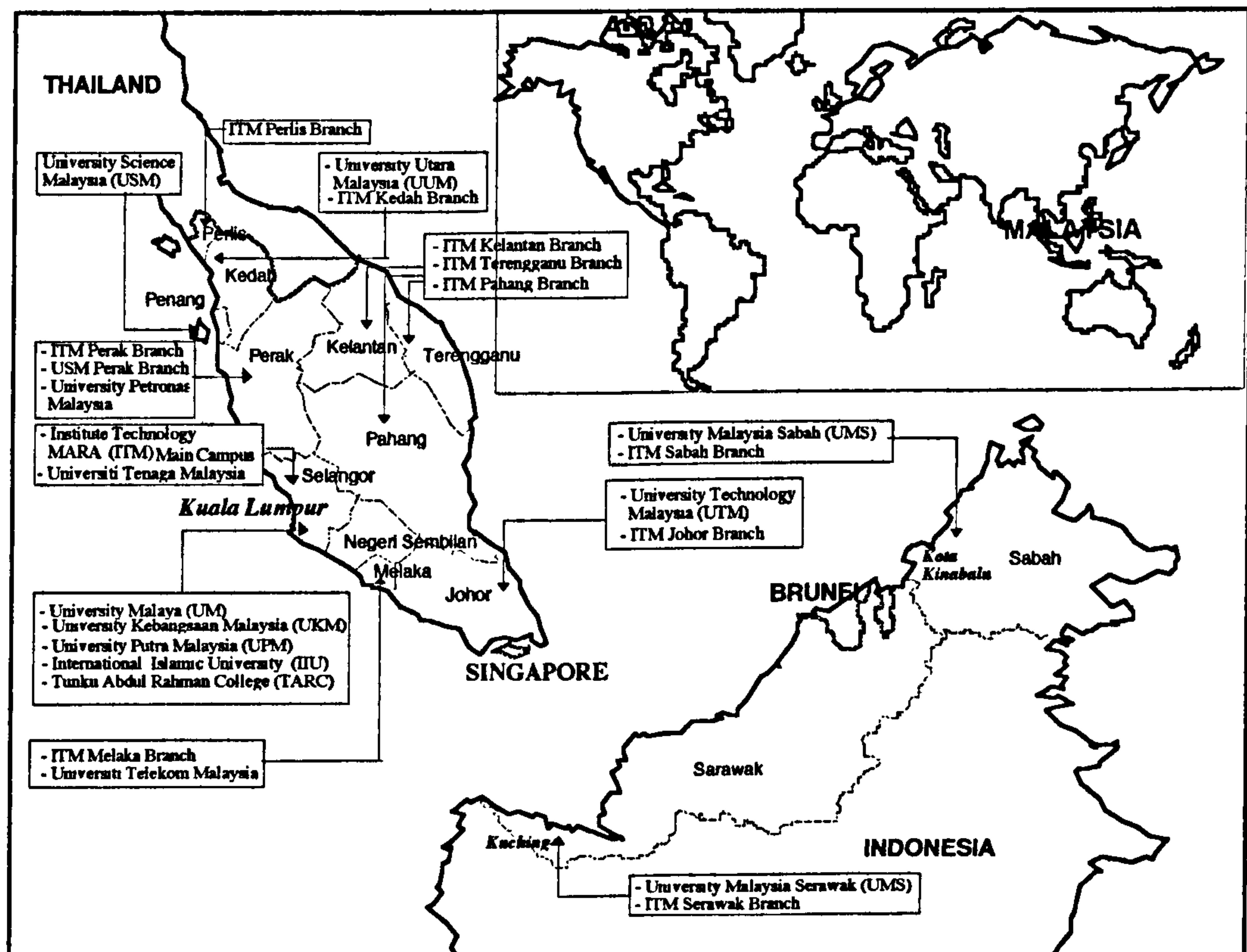


Figure 3.2. Locations of the universities and colleges in Malaysia

3.3 Architectural schools in Malaysia

There are four schools of higher learning in Malaysia which offers professional courses in architecture. They are University of Technology, Malaysia (UTM), University of Science, Malaysia (USM), the University of Malaya (UM) and MARA Institute of Technology (ITM). Although there are only four schools offering these

professional courses there are numerous private institutions offering the same. These privately funded schools are mainly engaged in conducting courses but they do not necessarily award the actual qualifications. A wide range of qualifications are awarded by such bodies as:

- Local professional examination bodies
- Government Examination bodies
- Foreign academic accreditation and validation examination bodies
- Foreign professional examination bodies. (Lim, 1994; Government Of Malaysia, 1996b)

An increasing number of prestigious foreign universities, particularly those from Great Britain, North America, Australia and New Zealand, have now ventured into partnership with locally established private colleges offering split-degree, credit transfer, validation and accreditation, distance learning and open university programmes. (Lim, 1994; Government Of Malaysia, 1996(b))

3.3.1 Accreditation and validation

In a limited sense, the government sector plays a role as an accreditation body. A special committee called the "*Jawatan Tetap, Penilaian dan Pengiktirafan Kelayakan*" (Secretariat for Evaluation and Recognition of Qualification) has been set up within the Ministry of Education to validate candidates for the civil service sector. This channel of validation is useful as it ensures a high degree of consistency of entry qualifications of government service at all levels.

In the case of architecture, the two bodies that govern the recognition of the awards are the government sector's "*Lembaga Akitek Malaysia*" (LAM) and the private sector's "*Pertubuhan Akitek Malaysia*" (PAM). The function of these two accreditation bodies is to ensure the quality of professional awards and practices in the country.

3.3.2 Structure of architectural practice in Malaysia

The existing structure of architectural practice in Malaysia is made up of architects, technical assistants and technicians. This structure could be explained in the form of a three tier organisational pyramid (please refer to figure 3.3)

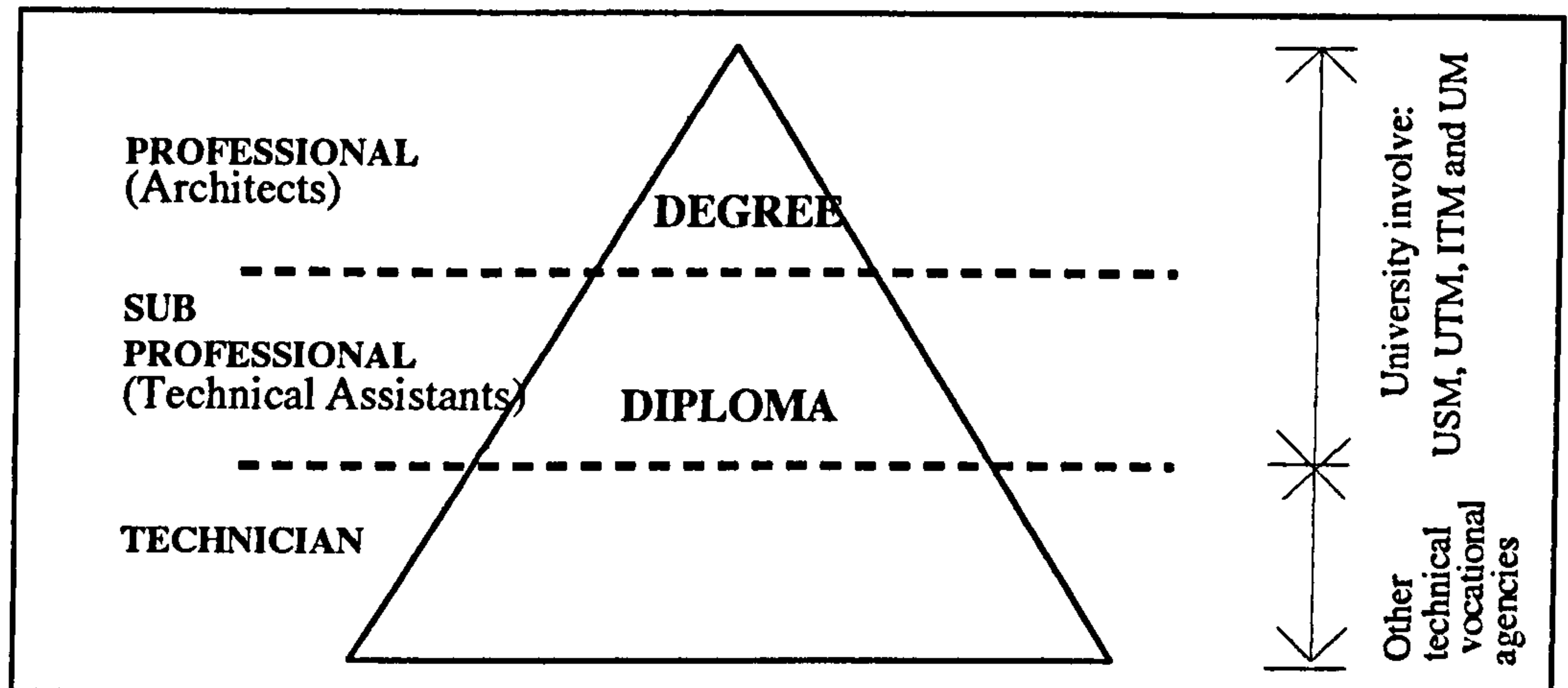


Figure 3.3: Three tier organisation pyramid of the structure of architectural practice in Malaysia.

The first level (the lowest tier in the professional ranking) is concerned with the training of technicians. Agencies that are involved in the training of technicians are mostly from the technical and the vocational schools from both the public and private agencies including the ones offered by Malaysian Institute of Architects (PAM) itself. The second level (the middle tier) on the other hand, is concerned with the production of the sub-professionals graduates. These graduates will be expected to work as the technical assistants in both the public and private sectors. At present, the country implies requires a greater number of technical assistants as compared to the architects (Lapuran PAM January, 1997). The third level (the top tier) is directly involved with the training of the professional architects. Public universities, namely, University of Science, Malaysia (USM), University of Technology, Malaysia (UTM), MARA Institute of Technology (ITM) and the University of Malaya (UM) (a full description of these universities are available in section 3.3.3 below). After completion of the professional training, graduates are expected to practice a minimum of two years before qualifying for the professional architect examination. Upon passing this examination, full practice rights as a professional architect is conferred to them.

The majority of students leaving the university on completion of their training usually serve the various government and semi-government agencies namely,

- Public Works Department (J.K.R) both at Federal and State level.
- State Economic Development Corporations.
- Urban Development Authority.
- Municipal and Local Governments.
- Private practice/architect's office.

where they will be directly involved in the implementation of the Malaysia Development Plans. Others it is hoped will proceed to do post-graduate studies in related disciplines and later join the various Research Establishment and Institutes of Higher Learning where they can contribute towards the advancement of Architectural Education.

3.3.3 Brief description of tertiary institutions offering professional courses in architecture

3.3.3.1 University of Technology Malaysia (UTM)

The Malaysian University of Technology (UTM) (previously known as the Institut Teknologi Kebangsaan) was established in 1972 to replace the former Technical College which begun in 1952. By the year 1960, courses leading to various professional examinations were incorporated into the teaching program including Architecture. This was the first course of architecture of any kind in Malaysia (Universiti Teknologi Malaysia, 1994; Government Of Malaysia, 1996(a); Government Of Malaysia, 1996(b)) The three year course leading to Diploma in Building Design was formerly organised to comply with the requirements of the Royal Institute of British Architects (RIBA). Later this responsibility was taken over by RIBA's local representative, The Malaysian Institut of Architects or Pertubuhan Akitek Malaysia (PAM).(Universiti Teknologi Malaysia, 1994)

With the formation of the university, the Departments of Architecture, Urban and Regional Planning and Quantity Surveying were brought under the Faculty of Built Environment. Later, the Department of Landscape Architecture was added. The courses offer Diplomas, Undergraduate Degrees, Postgraduate Diplomas, Masters Degrees and Doctorates of Philosophy.

In line with the University's objective which is to train competent technologists, the objective of the architectural program is 'to recognise the trends towards globalisation, changes in design education which are a consequence of the development of new technologies, including information technology and the department's desire to produce graduates who are equipped with the mind, skills, tools, methods and technical competency to excel in design at a level equal to the best anywhere, whilst conscious of the cultural heritage and the changing needs of the built environment'. The department is in the process of preparing itself, technologically, mentally and culturally, to be the centre of design excellence referred to at international level (Universiti Teknologi Malaysia, 1994)

3.3.3.2 University of Science, Malaysia (USM)

University of Science, Malaysia (USM) was established in 1969. It is located in Penang Island. It was the first university to concentrate in Applied Science Studies. USM has two branches, one in Kelantan, specialising in medical studies, and the other is in Perak, concentrating in Engineering Studies. USM is the first institution to have link programs with international institutions such as the University of Sheffield in the United Kingdom, and Yale University in the United States of America. The total number of academic staff is over 2000 while administrative and supportive staff number over 3000. There are 17 faculties in the university (Universiti Sains Malaysia, 1994; Government Of Malaysia, 1996(a)).

Architectural studies are grouped under the School of Housing, Building and Planning. Its objectives are to produce graduates with diverse skills and knowledge in the building and built environment. The normal duration of the courses is four years. The courses offered includes building economics and management, civil engineering, planning, architecture and applied arts. Students graduating from these courses will be awarded Bachelor of Science (B.Sc.) degrees with majors in any of the above mentioned disciplines. To further fulfill the professional requirement, an additional year is needed for the Bachelor of Architecture program (B. Arch) (Universiti Sains Malaysia, 1994).

3.3.3.3 MARA Institute of Technology (ITM)

MARA Institute of Technology (ITM) was formed in 1956. It is located in Shah Alam, Selangor. The institution is attended 100 percent by '*Bumiputras*', literally *son of the soil* or natives of Malaysia. The institute has set up several other branches within the Peninsular of Malaysia and East Malaysia. It offers social science, tourism, hotel and catering, business, journalism and law studies. By 1993, there were more than 1000 academic staff and more than 1500 administrative and support staff. There are 13 academic units in the institute (Institut Teknologi MARA, 1995(b); Institut Teknologi MARA, 1996; Government Of Malaysia, 1996(a); Government Of Malaysia, 1996(b)).

ITM strives to become a renowned institute of higher learning. Its aim is to promote academic excellence in higher education and professional training necessary for the country's socio-economic development. ITM consists of a total of ten campuses located in almost every state in the country. Two of its campuses offer architectural training courses and programmes. One is in the Perak branch and the other is in the main campus in Shah Alam (Institut Teknologi MARA, 1995(a); Institut Teknologi MARA, 1995(b); Institut Teknologi MARA, 1996)

Architectural studies began in July 1967 with a beginning enrollment of 60 students. It was initially housed under the School of Applied Arts. In 1971, the school changed its name to the School of Architecture, Planning and Surveying. Today, the School of Architecture, Planning and Surveying is flourishing due to its presence in the Klang Valley. It has eight departments conducting fourteen courses. It also has a student population of over 1,723. The study of Architecture is divided into two. First, the sub professional level is a four year course which awards a Diploma in Architecture (ITM). It is recognised professionally as PAM I. Second, the professional level is an addition of two years of studies leading to a Bachelor in Architecture (ITM) recognised professionally as PAM II. (Institut Teknologi MARA, 1995(a); Institut Teknologi MARA, 1996)

3.3.3.4 The University of Malaya (UM)

The University of Malaya (UM) is the oldest university in Malaysia. It originates from the University of Malaya, established in 1949 in Singapore (now known as the Republic of Singapore). It became the national university in Malaysia in 1962. The university strives constantly for excellence in all its undertakings, whether in teaching or research, and to produce students and leaders of the highest calibre. The

current objectives of the university are mainly geared towards fostering close relationship with the private sector vis-a-vis research and teaching. (Government Of Malaysia, 1996(b))

Its concentration is on medicine, law, engineering, sciences, economics and administration and teaching. Recently, the university has started to expand into the arts and social sciences. A new faculty of architecture was established in 1994 offering architectural professional programmes leading to Diplomas and Bachelors in Architecture.(Government Of Malaysia, 1996(a); Government Of Malaysia, 1996(b))

3.4 Architectural training programmes of Malaysian tertiary institutions

For the needs of this research, tertiary institutions namely, University of Science, Malaysia (USM), University of Technology, Malaysia (UTM) and MARA Institute of Technology (ITM) are chosen to be investigated (the reason for such selection is explained in the selection of sample in Chapter 5). The complete spectrum of the training programmes of the above institutions are shown in figure 3.4.

Figure 3.4. Training Structure of participating institutions

University Of Technology Malaysia (UTM)

Course	Duration	Entry Requirements.	Training Level					
Diploma in Architecture	3 Years	SPM(O-Level) / SPM with Polytechnic Certificate / Experience						
Degree Course Bach. Arch (PAM I and II)	3 Years	Dip. Arch (UTM) or equivalent						
No of Years Study			1	2	3	4	5	6




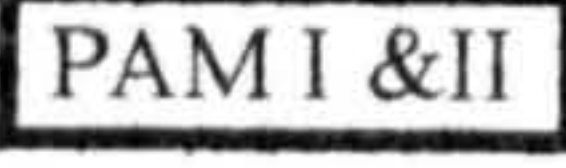
University of Science Malaysia (USM)

Course	Duration	Entry Requirements	Training Level					
Bachelor Science (Arch) Integration course.	4 Years	STPM(A-Level)/Science Matriculation/ SPM with Polytechnic Certificate / Experience						
Bach. Architecture (PAM I and II)	1 Year	Bach. Science (USM) or equivalent						
No of Years Study			1	2	3	4	5	

MARA Institute Of Technology (ITM)

Course	Duration	Entry Requirements	Training Level					
Diploma (PAM I)	4 Years	SPM(O-Level)/SPM with Polytechnic/ Experience						
Adv. Diploma Degree Course (PAM II)	2 Years	Dip. Arch (ITM) or equivalent						
No of Years Study			1	2	3	4	5	6

LEGEND

	Sub professional level
	Professional level
	Practical training (year out)
	Recognised professional architectural degree by Pertubuhan Akitek Malaysia (PAM) or Malaysian Architect Association

(Source: (Universiti Sains Malaysia, 1994; Universiti Teknologi Malaysia, 1994; Institut Teknologi MARA, 1995(a); Institut Teknologi MARA, 1995(b); Institut Teknologi MARA, 1996)

The training programmes shown above can be divided into two levels:

1. The sub-professional level:

At this level, the aim of the program is to prepare the student to be awarded a diploma in architecture and when he graduates, he is expected to work as a technical assistant in the public or private sector. In ITM, the program takes four years and the award is recognised professionally by PAM as PAM I. In the case of UTM and USM, this professional award is only awarded after the student enters the professional level that is in the fourth year or even in the case of USM, the fifth year.

2. Professional level:

At this level the aim of the program is to prepare a student for professional training which will qualify him to be a fully fledged architect (i.e. after two years of practice and passing the qualifying professional examination). In this program, a student will normally take another two to three years after qualifying from the first level. During the program, there will be at least six to twelve months of practical training in what is called 'year out'. During this period students will be exposed to architectural practice through working in various architectural firms locally or internationally. This is the time when the students are expected to learn through

experience in preparation to be a competent architect.

The training programmes shows the domination of formal teaching. Experiential learning is severely lacking. It is perhaps due to this reason that Smith (1987) said that “In the modern school of architecture, many students find it curiously difficult to relate their experiences in the lectures to their experiences in the studio. Although they are offered extensive information in the lectures about building technology, human behaviour, culture and so on...”. To add more problems to the situation, the formal teaching were again split into two: **the lectures**, where students will learn the general principles and theories and **the studios**, where they are expected to apply this information to solve a particular design problem. Failing to synthesize knowledge from these lectures into practice in design studio is the key question that we ask ourselves and it is the objective of the research to find out the causal reasons to this problem.

3.5 Teaching methods in architectural curriculum

An overview of the teaching methods practised in the architectural curriculum consists of the following:

3.5.1 Studio method

The studio method of teaching has been accepted in as the backbone in the architectural education with supplemental lectures and practical running parallel to studio work. This approach to architectural education is successful mainly because of personal involvement of the student and the lecturers who is the best motivating factor in education. In addition, Allen, (1980) referred studio as real-life experience condensed into a manageable amount of time and space.

“Here (studio) the student works on an isolated slice of the world, a design problem, trying paper solutions and judging the result of each with the help of a more experienced designer. By trying things and guessing or observing how well they work, time after time, year after year, the student gradually and painfully becomes a knowledgeable designer” (Allen, 1980: 22).

He strongly regarded studio as an open laboratory, where it can be the most natural and productive way of learning about construction technology in which the

learner can best appreciate through the sense of touch. Many researchers such as Meunier (1980), Smith (1987), Reno (1992), and Allen himself believed that technological subjects should be brought together in the studio and taught concurrently with the design subjects. Nevertheless, this has brought other problems such as time constrain, space and lack of staff.

3.5.2 Lecture Method.

Formal lectures are used to define the basic areas of study, principle and theory. Lectures are given to students in a traditional lecture room setting with a normal class size of about fifty students. Lecturers use different styles to present their material, some require students to take notes while others provide full handouts, although a mixture of the two is more commonly practiced. Visual aids are used when available and the overhead projector is the most popular apparatus for presenting both diagrams and notes. This is the most common and universal method of delivering information and it is used by almost every discipline. The main problems to this method are:

1. The student sometimes fail to relate the lectures to design. Two examples are given by Gelernter (1988) to show this deficiency. First, “lecture teachers often complain that essential concepts they have taught about, say, building construction or person-environment relations, do not seem to show up in the student’s design project” and second, “studio teachers often complain that students do not know the first thing about say, building services even though they have just completed several years of lectures on the subject”
2. Lectures are often one-way communication. Generally, the lecturer gives a monologue of the message he is set to convey. Discussion, when there is one is normally carried out at the end of the period. It is, however, too little to the immense amounts of syllabus to cover within a certain predetermined time.
3. Because the amount of information to be transmitted to the students is enormous, the lecturer often has to squeeze information into short lectures or may leave out some of important items of a particular topics. As a result, it is normally impossible to run lectures parallel to the design work taught in the studio.

3.5.3 Practical/laboratory method

The practical method is used together with the lecture method to explore practical applications to some of the basic principles of the lectures, for instance, the laboratory test on the strength of building materials, or the person-environment relationship. Usually, this practical laboratory experiments relate directly to the lectures. It does not, however, contribute to the mainstream of architectural work because it is treated as an experiment to prove something. In the case of architectural education the laboratory is used for creating or exploring new creation. Since this is a part of the lecture, the disadvantages are similar to that expected from lecturing methods.

3.5.4 Site experience

Experience on the project has proven to be very useful and should be encouraged in architectural education especially towards the understanding of technical subjects such as construction technology. The advantages are numerous. For example, it helps the students understand the subject better by observing and experiencing the actual project being carried out. In addition, the students will also experience and understand the fundamental characteristics of building materials like the wood, masonry, steel, concrete and other finishing materials.

Another plus point to students is they have the opportunity to appreciate the art and craftsmanship of building. The most important advantage is students will be able to understand the relationship between buildings and its context (physically and socially). The main drawback of this method is it is very expensive and time consuming (Newman, 1978; Meunier, 1980).

3.6 Learning and teaching methods in architectural studies: A methodological mismatched

Various studies have been carried out to show the importance of matching the learner's cognitive style with teaching styles in order to optimize the performance of teaching and learning (please refer to Chapter 4). Learning in matched conditions (in which instructional style is matched with students' preferred learning styles) has been demonstrated to be significantly more effective than learning in mismatched ones (Pask, 1976; Cross, 1985; Ford, 1985; Pask, 1985; Entwistle, 1988)

In the architectural discipline, there is evidence suggesting that there is a mismatch between learning style and teaching style (Lawson, 1975; Lawson, 1979; Lawson, 1990). Even though there is no empirical evidence to prove this in architectural training, experiments has been conducted in other disciplines. One such study was done by Ford (1995) in engineering studies. He suggested that there is a mismatch between the learning style of the engineering students and the teaching characteristics of many engineering teachers. The survey was conducted in University of Sheffield using the *Short Inventory of Approaches to Study and Study Preference Questionnaire* (a self-completion inventory developed by Entwistle). According to the test, when students were classified under biases towards holist and serialist strategies, learning would be significantly better in matched condition than in the mismatched conditions as forwarded by Pask and Scott twenty years ago. However, according to Ford, if learning progress is to be made, the questions of relating such styles with teaching styles, which poses problems to the design of learning materials, must be resolved.

3.7 Summary

In this chapter we have provided information about higher education and architectural education in Malaysia. The main objective is to familiarise the reader with the architectural learning situation and some generic problems in the architectural schools particularly in Malaysia. In the next chapter, we will commence by examining in detail the literature regarding the learning theories and the learning requirements in architectural education.

Chapter 4

A Review On The Theories Of Learning

4.0 Introduction

This chapter undertakes to introduce some of the major learning theories concentrating on those aspects that have implications on learning and information retention necessary as it is from these theories that the general understanding of learning, methods of instruction and learning styles were developed. The theories of learning are wide and it is not the intention of this chapter to describe them in detail since this will be difficult if not impossible to do. However, attempts will be made to draw together the fundamental principles.

The subject of learning will be introduced by presenting a cross section of the theories which have been 'formulated' over the years and relate these in simple terms to the learning methods practised by students in the architectural school in general and Malaysian architectural school in particular.

4.1 Attempts to define learning

Because most human behaviour is learned, investigating the principles of learning will help us understand why we behave in the way that we behave. People discover that when they do not know something (which they consider worth knowing), they try to seek information and experiment so that they either understand or solve the problem. In doing these activities they gain experience and find ways of learning. As for the teacher, his job as he sees it, is to help people find answer/s in a reasonable, orderly and satisfying manner (Sotto, 1994). Learning is viewed as a process so important to the successful survival of human beings that the institution of education

and the school has been devised as a procedure for making learning more efficient. As mankind has become more aware of the importance of learning, there has been growing interest in the study of learning correspondingly.

There are variety of definitions of learning but before we consider these definitions, it may be valuable to ponder on some examples representing many different everyday forms of learning:

1. A baby cries for the want of food. He is picked up, fed and comforted. The baby enjoys the 'fuss' just as much as being fed. Soon, he cries whether he is hungry or not to gain attention.
2. A person learns to skate. At first, the skates are an encumbrance and the learner is continually falling over. The problem is that he is trying to apply the rules he knows already, that is walking. Before long, he learns to spread the body weight properly and discovers how to control the skating blade through a series of body movements. After sometime, the pupil seems, almost without thinking, to be able to go wherever he pleases.
3. Learning a part for a play. The actor would probably read the first pages several times and then proceed to grasp the text a line at a time to see if he can remember the next part using the previous line as a cue. As the learner learns each section, he proceeds to the next, occasionally revising in order to check that he has not forgotten a line or section. Eventually, given the correct cue, the actor will be able to deliver the appropriate line.
4. Trying to acquire knowledge. A student in a library reads through books, makes occasional notes, re-reading certain sections and sometimes refers to other books for clarification so that at a later date, he may apply the gained information in another situation, perhaps in an examination.
5. A trainee, in an attempt to develop his understanding, listens to an explanation on the workings of an electric motor. He takes notes, draws sketches, and asks questions from the instructor when unsure about some point. He may go away and undertake some investigation of his own. Later he may be able to explain, with understanding, how an electric motor works.

Whilst the above examples of learning are by no means comprehensive, they are perhaps sufficient to demonstrate the common features which are involved:

1. Learning took place during some activity with a purpose.
2. Various responses were employed to reach a solution.
3. Having found the 'answer' to the problem, it produces some kind of change in the performance of the individual concerned.

The examples show the evolution of **learning by mere practice and learning by the interaction with the environment**. Having said all these, we shall now consider a number of definitions of learning given by some distinguished authors:

Learning is:

1. "...relatively permanent change in behaviour potentially which occurs as a result of reinforced practice." (Kimble, 1961: 6)
2. "...a long-lasting change in knowledge, attitude or skill, acquired through experience." (Rowntree, 1981: 153)
3. "...the relatively permanent change in a person's knowledge or behaviour due to experience." (Mayer, 1982: 1040)
4. "...any change in an individual that expresses itself in a relatively stable form of behaviour, and which is the result of an interaction with the environment, mediated through the senses." (Borger and Seabourne, 1982: 13)
5. "...a relatively permanent change in behaviour or in behavioural potentiality that results from experience and cannot be attributed to temporary body states such as those induced by illness, fatigue, or drug." A revised form of Kimble's definition of learning (Hergenhahn and Olson, 1993: 7)
6. "...a change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth... the change must have more than momentary permanence, it must be capable of being retained over some period of time". (Gagne, 1985: 2)

It may be implied from some of the given definitions that learning is not mere education; It is a systematic or planned procedure designed to produce certain knowledge, skills, understanding, attitude and behavioural patterns. Equally, learning cannot be said to be maturation as espoused by Biggs, (1979). Maturation is a developmental process which a person may manifest different traits from time to time; it is an 'individual' variable where as learning is a change in an individual not heralded by his genetic inheritance.

From the above definitions we can deduce some similarities. The first is that these authors agree that learning is initiated by an experience. The second is that this experience will bring about a change. The third point which is commonly shared by the authors is that such change is relatively permanent. Many definitions seem to stress on the importance of experience. In the behavioural approach reinforced practice and contiguity between stimulus and response are necessary experience ingredients for learning (Kimble, 1961) while cognitive theorists feel experience is useful in the acquisition of information (Hergenhahn and Olson, 1993).

Psychologists such as Garry and Kingsley (1970), Biggs (1979), Kolb (1984), Biehler and Snowman (1993) and Hergenhahn and Olson (1993), agree that an individual must be equipped with **knowledge, understanding and some training** in the art of problem solving and of learning how to learn so that he can come out with the appropriate answers and suitable modes of behaviour for unexpected situations. They go on to suggest that three main variables that influence learning are: first, individual; second, the task; and third the environment. In this chapter, we will try to relate these variables into the learning of construction technology by analysing the **learning behaviour or characteristics of the individual learner and the learning environment which includes learning and teaching methodologies.**

4.2 Learning theories

A great deal of literature has been written on the theories of learning. In this chapter some theories of learning will be examined in order to determine what relevance they have to the learning of construction technology. Further in this chapter points relevant to the learning of construction technology will be emphasised.

Over the years there has been a great deal of controversy within the field of theoretical psychology with regard to learning theories, indeed much of the literature tends to classify these theories into two main groups: Stimulus-Response (S-R) or sometimes referred to as **Behaviourism and Cognitionism.**

“Most psychologists who prefer to emphasise *Stimulus Response (S-R)* relationships interpret learning as habit formation, by which they mean associative learning, that is, acquiring a *connection* between a stimulus and a response that did not exist before” (Hill, 1972).

“Other psychologists, not convinced that it is most profitable to treat all learning as habit formation are impressed by the role of understanding in learning, or, in more technical term, the role of *cognitive processes*. Examples of cognitive process would be the ability to follow maps over routes we have never taken before; and to reason our way to conclusions previously unfamiliar to us” (Hilgard and Atkinson, 1967).

These two quotations by Hill, (1972) and Hilgard and Atkinson, (1967) are typical of the approach of ‘Behaviourists’ and ‘Cognitives’ respectively. However, the sharp distinctions which once existed between the various schools of learning have gradually disappeared as research on learning has become more sophisticated. These modifications have brought many theories into juxtaposition as well as extending lines of inquiry in new directions (Garry and Kingsley, 1970). We now look at these two theories in detail.

4.2.1 Behaviourism (Connectionism)

4.2.1.1 Definition and historical aspect

In behaviourism or connectionism, it is believed that learning results from an association (connection) of ideas. That means an idea impinges on the learner as a stimulus which triggers another idea as a response. If the connection between the stimulus and response is strong enough, the learning material is learnt well, and can be well remembered. In contrast, if this connection becomes weak, remembering is disturbed, that means forgetting has occurred (Child, 1981). Behaviourists based their theories on what they found from experiments with animals. They believed that learning is a behaviour or a habit that occurs in the same way in animals and human beings. Thus, they generalised what they found from work with animals to human beings. According to (Child, 1981):

“Before the last century, human being had never really been subject of scientific experiment. The establishment by Wundt of a psychological laboratory in Germany in 1879 saw the beginning of a more objective attack on the study of animal and human behaviour, and the impetus thus given soon created a firmer foundation for psychology. At the turn of the century, Pavlov in Russia and Thorndike in America directed their attention to detailed study of how animals and humans behaved in given laboratory circumstances rather than relying on introspective beliefs or feelings. The earliest and most extreme

'behaviourist' was Watson. His fundamental conclusion from many experimental observations of animal and childhood learning was that stimulus-response(S-R) connections are more likely to be established the more frequently or recently an S-R bond occurs. A child solving a number problem might have to make many unsuccessful trials before arriving at the correct solution. Of the many responses he or she can possibly make in an effort to solve the problem, the unsuccessful ones will tend not to be repeated; thus there will be an increase in both the frequency and recency of successful responses until a correct S-R pattern appears. Trying alternative paths in the solution of problems of any kind is known as *trial and error learning*".(Child, 1981: 84) .

4.2.1.2 John B. Watson

The early study on learning is devoted to behavioural learning theories. Behavioural theories were proposed by psychologists who argued that the only scientific way to study learning is to base all conclusions on observations of how overt behaviour is influenced by forces in the external environment (Biehler and Snowman, 1993: 322) .

John B. Watson (1878-1958) was believed to be the founder of behaviourism (Biehler and Snowman, 1993). In his book, Biehler reported that Watson believed that learning psychologists' main concern should be with behaviour and how it varies with experience. Watson also believed that "all human beings come equipped with at birth are few reflexes and few basic emotions", and through what he termed as *classical conditioning*⁵ these reflexes become paired with a variety of stimuli. He emphatically denied that we are born with any mental abilities or predisposition. For him, learning occurred simply because events followed each other closely in time. He called himself a behaviourist to emphasise his main point that psychologists should base their conclusions exclusively on observations of "overt" behaviour (Hergenhahn and Olson, 1993: 192-194) .

To stress his doctrine of behaviourism, Watson tried to establish conditioned responses in a human subject. In his classic experiment "*The Albert*" he demonstrated that human behaviour could be conditioned. He encouraged an eleven-month old boy named Albert to play with a white rat (some accounts of this experiment mentioned a rat, others mentioned a rabbit). When Albert began to enjoy this activity, Watson suddenly hit a steel bar with a hammer just as the child reached for the rat. In

⁵ Classical conditioning is described as a naturally occurring involuntary response becoming associated with a previously neutral stimulus.(Biehler and Snowman, 1993) p. 325

observations of infants, Watson had discovered that a sudden, loud sound frightened most children. When Albert came to associate the previously attractive rat with the frightening stimulus, he not only responded with fear but generalised this fear to anything white and fuzzy. Watson was so elated with his success at conditioning Albert that he was willing to say this extreme statement:

“Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any specialist; I might select - doctor, lawyer, artist, merchant-chief, and, yes, even beggar man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors" (Watson, 1926 in Hergenhahn and Olson, (1993) : 192).

According to (Hergenhahn and Olson, 1993: 193-194), Watson succeeded in making learning one of the central topics of psychology but, his methodology invariably left a lot to be desired, for example, he failed to show how conditioning can be an explanation of the acquisition of knowledge, a principal learning objective.

4.2.1.3 Edward Lee Thorndike

While Watson thought that the presence of simultaneous stimulus and response (S-R) is important for learning, Thorndike paid more attention to the response. Thorndike looked at the (S-R) bond somehow differently from Watson. Thorndike believed in the law of effect. He suggested that the satisfaction with the correct response makes the (S-R) bond stronger, while dissatisfaction does not necessarily stop learning, but causes the respondent to continue looking until a satisfying solution is achieved by *trial and error*.⁶ In terms of education, he believed that educational practices should be studied scientifically. To him, there should be a close relationship between the knowledge of the learning process and teaching practices. Thus, he expected that as more was discovered about the nature of learning, more could be applied to improve teaching practices. Thorndike had a low opinion of the lecture technique of teaching that was so popular then (and now). He wrote:

⁶ An example of trial and error learning is that, a beginner in typewriting begins his learning by just pressing the buttons on the keyboard, and seeing how well he writes. So trial and error learning is self-controlled by feedback from the result of the learning

"The lecture and demonstration methods represent an approach to a limiting extreme in which the teacher lets the pupil find out nothing which he could possibly be told or shown. They frankly present the student with conclusions, trusting that he will use them to learn more. They ask him only that he attend to, and do his best to understand, questions which he did not himself frame and answers which he did not work out. They try to put him an educational fortune as one bequeaths property by will" (Hergenhahn and Olson, 1993: 74):

He also said,

"The commonest error of the gifted scholar, inexperienced in teaching, is to expect pupils to know what they have been told. **But telling is not teaching.** The expression of the facts that are in one's mind is a natural impulse when one wishes others to know these facts, just as to cuddle and pat a sick child is a natural impulse. But telling a fact to a child may not cure his ignorance of it any more than patting him will cure his scarlet fever".(Hergenhahn and Olson, 1993: 74).

According to Thorndike, good teaching involves first of all knowing what you want to teach, what response to look for and when to apply satisfies or rewards. He believed educational practices should be regulated according to verified outcomes of scientific policies. He was the inventor of many intelligent tests, spelling and arithmetic tests aimed at measuring a certain level of ability. However, like many of the Connectionists, Thorndike stressed the act of imparting knowledge as a learning task and also stressed the subordination of insight and understanding to drill and habit, but he failed to show what arrangement makes a problem hard or easy and how connections can be arrived at in other ways. In summary, Thorndike recognised the acquisition of knowledge through habit as a learning task but denied understanding and the function of change in attitude, ideas and values as learning tasks.

4.2.1.4 Ivan Petrovich Pavlov

In congruence with the behaviourism, a Russian scientist Ivan Pavlov also thought that behaviour was a response to stimuli, but unlike Watson and Thorndike, he as a physiologist began his work on the physiological reflexes. He published reports in his famous experiment where in the experiment he induced a dog to salivate when a bell was rung by building up an association between the bell and food. On the basis of this experiment, he proposed that the association was established because presenting food just after the bell was rung '*reinforced*' the response. If reinforcement was not supplied from time to time, he discovered, the response would disappeared, or

extinguished. Pavlov also pointed out that a dog conditioned to salivate at the sound of the bell would tend to salivate at other sounds, such as a whistle, he referred to this tendency as '*stimulus generalisation*'. Such generalised response could be overcome by supplying reinforcement after the bell was rung but never after a whistle was sounded. When this occurred, he said, '*discrimination*' had taken place. Later he generalised his findings in physiology to psychology and came to say each kind of behaviour including education and learning was nothing but conditional reflexes.(Child, 1981; Biehler and Snowman, 1993; Hergenhahn and Olson, 1993).

What Pavlov meant by conditioning was what psychologists called **association**. He said that:

"Thus the temporary nervous connection is the most universal physiological phenomenon both in the animal world and in ourselves. At the same time it is a physiological phenomenon, which the psychologists call association, whether it be combinations derived from all manner of actions or impressions, or combinations derived from letters, words, and thoughts. Are there any grounds for differentiation, for distinguishing between that which the psychologist calls the temporary connection and that which the psychologist terms association? They are fully identical, they merge and absorb each other".
(Pavlov, 1955: 251)

Referring to Bolles, (1979) and Hergenhahn and Olson, (1993), Pavlov's general concern on learning was that all learning in man and animals was due to conditioning.

4.2.1.5 B. F. Skinner

While Pavlov's experiments were ingenious and thought provoking, theorists interested in learning soon realised that classical conditioning applies only to essentially involuntary reflex actions (such as salivation or fear). Experimenters sought other ways to analyse associations between stimuli and responses which they called *operant conditioning*⁷. The most successful psychologist on this type of associations study was B. F. Skinner. In his theory, a voluntary response is strengthened when it is reinforced. The basic idea behind operant conditioning is that all behaviours are

⁷ Operant conditioning, is described as a voluntary response influenced by consequences that follow and is strengthened when it is reinforced (Biehler and Snowman, 1993) page 326

accompanied by certain consequences, and these consequences strongly influence (some might say determine) whether or not these behaviours are repeated and at what level of intensity.

The idea behind Skinner's approach is that "*learning should be shaped. Step-by-step programs using stimuli and consequences should be designed to lead students to a predetermined end result*". Skinner's theory of reinforcement accounts for quite a few types of behaviour, but several critics and some of his fellow stimulus-response theorists point out that other aspects of behaviour that cannot be traced to reinforcing experiences. Sears and Bandura, for example, have demonstrated that children do not necessarily have to be reinforced in order to acquire certain types of behaviour, they may simply imitate the actions of others, particularly when they identify with them (Hergenhahn and Olson, 1993).

The contribution of Stimulus-Response or Connectionism to our understanding of learning lies perhaps in the way they treated '*understanding*' which is a major learning task. They showed the importance of reinforcement and the habit of forming hierarchy which permits the maximum utilisation of past experience in the solving of present problems. Therefore, in developing '*understanding*', it follows perhaps that habit and reinforcement are helpful because the more one practices, the more developed is the level of understanding.

4.2.1.6 Ruling out stimulus-response(S-R) structure

While many psychologists and educators are enthusiastic about application of S-R theory to learning/teaching, some have drawn attention to the limitations and disadvantages of such theory. These criticisms are either on the basic assumptions of the S-R theory itself or the specific techniques used in the experiments.

Combs and Snygg (1959), for example, had criticised Skinner's environmental view of determinism because they felt it led to the assumption that human beings are similar to rats in a Skinner box. They also pointed out that Skinner's approach to shaping behaviour requires that someone must know what the 'right' goal was in order to effectively manipulate the required forces.

Rogers (1951, 1956 and 1963), in his own view, felt that the S-R theory's view on human behaviour was a threat to efforts to improve mental health. He believed that human beings needed to feel they were controlling their own behaviour.

Maslow (1968), was concerned by the extent to which basic assumptions of S-R theory led to the basic assumptions that characteristics were of no significance and that parents and teachers should try to shape behaviours. He stated,

“It is necessary in order for children to grow well that adults have enough trust in them and in the natural processes of growth, that is, not interfere too much, not make them grow, or force them into predetermined designs, but rather let them grow and help them grow”
(Maslow, 1968).

Many of Skinner’s critics argue that teachers become too concerned about manipulating the classroom environment and students practise control for the sake of control. They argue that teachers who make substantial use of operant conditioning techniques might, without realising it, tend to use such methods for certain reasons. Firstly, they use operant conditioning because they want to produce behaviour that have been carefully prescribed or pre-selected as likely to benefit students. Secondly, they want to make life easier for themselves and thirdly, they are reinforced by the ‘measure’ to which they can control others. In such cases, they conclude learning may be limited rather than enhanced.

Unlike animals, human beings are capable of engaging in self-directed behaviour that might be more beneficial to them than behaviour selected by others. The manipulation of one human being by another might make a difference, because it raises the question of who is to decide what will be beneficial - the controller or the individual.

In deciding on the ‘right’ goals, teachers might inadvertently choose those that will benefit them more than their students because of a desire to establish a class routine that will simplify instructions or because shaping the behaviour of others gives them a sense of power. Since all rewards are dispensed by the teacher, students seldom feel that their own behaviour is reinforcing and it is difficult for a teacher not to feel a sense of importance and power. Furthermore, unlike the rats or the pigeon, human beings can use language and thought to enhance exploration of ideas on their own and organise and adapt to experiences that make them potentially capable of even more impressive accomplishments if left to their own devices.

Those who favour the views of Combs and Snygg (1959), Maslow (1968), and Rogers (1951, 1956 and 1963), however believe that the individual will have greater freedom to choose from non-arranged encounters than from experiences that are highly structured by others.

4.2.2 Cognitionism

4.2.2.1 Cognitive learning theory

Many have argued that human behaviour is too complex to be explained and solved all in a simple Stimulus-Response theory. Perhaps this is one of the reasons why some psychologists are dissatisfied with the behaviourist-associationist point of view. A new set of ideas, often referred to as the Cognitive-discovery view because it stresses thinking (cognitive) relationships were formulated. This led to the formation of cognitive learning theory which is discussed below. The most important point in cognitive theory is it is believed that the mind is not a blank slate at birth and that the mind is active, not passive. The mind is capable of weighing alternatives (thinking) and has the built-in need to reduce ambiguity and to make everything as simple as possible (Hergenhahn and Olson, 1993: 445). The teachers accepting this view are not mere arrangers of the learning environment; rather, they are active participants in the learner-teacher relationship which is totally opposed to the behaviorist-oriented teachers that believe they must create the environment that allow the students to be reinforced for behaving or learning in accordance to the desired objectives.

4.2.2 3 Gestalt theory

Despite attempts to differentiate cognitive learning theory forms other form of learning theories, it is perhaps worth mentioning that there is no clear line of demarcation between cognitive and gestalt learning theories. In fact there are many in which these two theories overlap. Some writers group them together but for the purpose of this thesis, we shall treat them separately.

Gestalt psychologists were the main opposites to associationist (S-R) view of memory and have made more contributions to the development of cognition theory.

“Learning to the Gestaltist, is a cognitive phenomenon. The organism ‘come to see’ the solution after pondering a problem. The learner thinks about all of the ingredients necessary to solve a problem and puts them together (cognitively) first one way and then another until the problem is solved.” (Hergenhahn and Olson, 1993: 255)

'*Gestalt*' is the German word for configuration or organisation, and *Gestalt Theory* suggests that we perceive the things as a whole. It is commonly believed that the way we establish perceptions differs from the way the things appear to us. When we look at a figure, we gradually learn to distinguish it from its ground (Hergenhahn and Olson, 1993)

German psychologists like Wertheimer (the earliest worker to attempt a cognitive interpretation), Kohler and Koffka founded *the Gestalt School of psychology* which concentrated on the study of perception for a better understanding of learning. Their thinking was on the basis that the '*whole is more than the sum of the parts*'. In short, things are perceived meaningfully as a whole, not as parts which makes up the total figure. Our perception systems are organised in such a way that they derive shapes from inputs however simple it might be (Hergenhahn and Olson, 1993)

Our vision can sometimes selectively perceive some parts of a figure as a shape and the next time perceive the ground as the original shape. The face-vase illusion devised by Rubin, the Gestalt psychologist, is a well-known example ⁸.

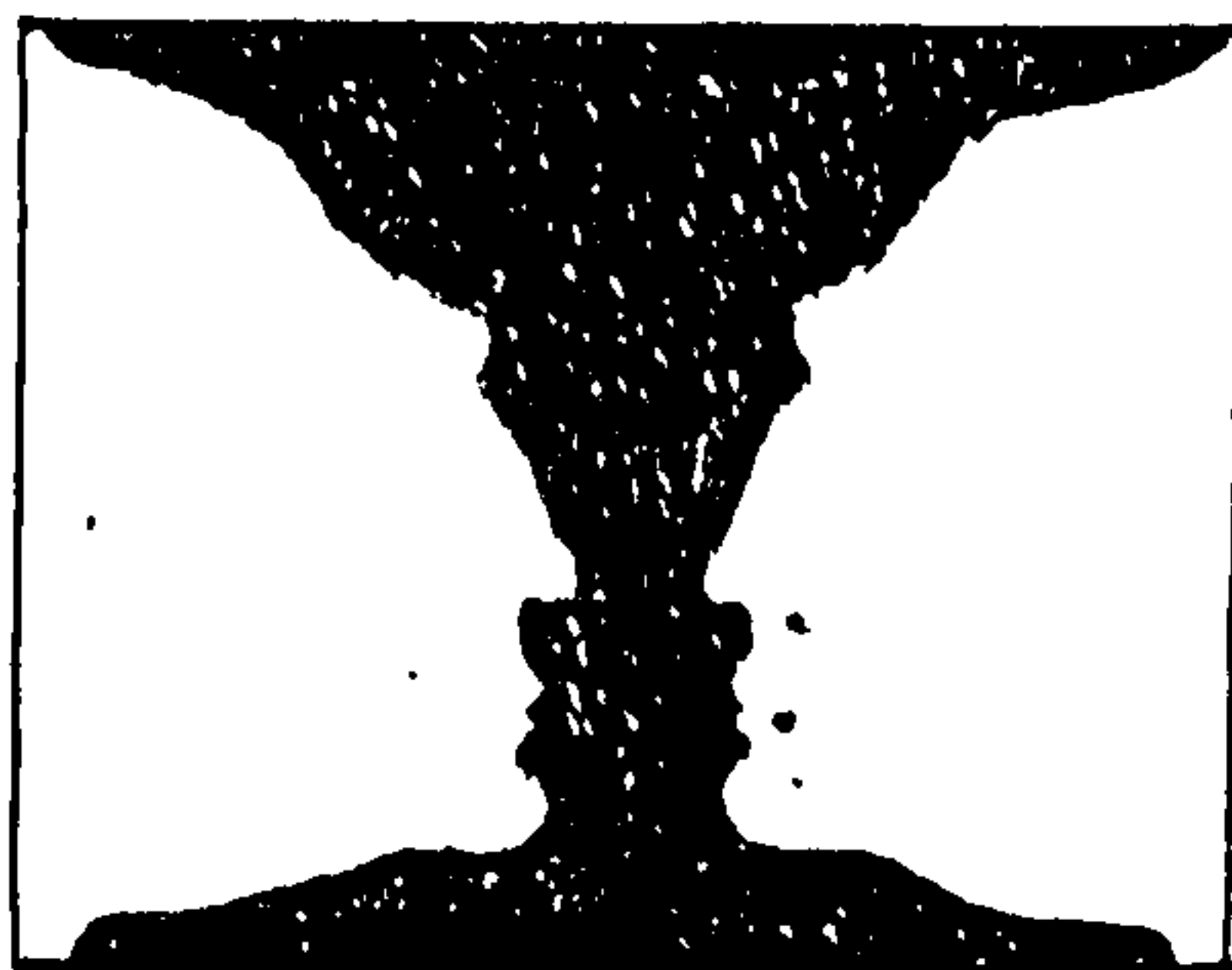


Figure 4.1. Face-vase illustration devised by Rubin

⁸ The Gestalt psychologists formulated several principles/laws to describe how we perceive the parts of a whole figure. In architectural learning, Gestalt theory was found to be useful especially in the area of perception, for example in the use of colours, lines to perceive vastness and narrowness of a defined space. See (Hergenhahn and Olson, 1993: pp. 255 - 257).

Bower and Hilgard, (1984), summarised learning in Gestalt Theory as follows:

1. *Practice:*. Our memories are thought to be traces of perceptions; association is a by-product of perceptual organisation. The laws of perceptual grouping also determine coherence of elements in memory. Repetition of an experience builds cumulatively on earlier experiences only if the second event is recognised as a recurrence of the earlier one. **Successive exposure to a learning situation provides repeated opportunities for the learner to notice new relationships so as to provide for restructuring the task.**
2. *Motivation:*. The empirical law of effect, regarding the role of rewards and punishments, was accepted by Gestalt psychologists, but they differed from Thorndike in interpreting it. They believed that after-effects did not act automatically and unconsciously to strengthen prior acts. Rather, the effects had to be perceived as belonging to the prior act as placing the organism into a problem situation; **rewards and punishments acted to confirm or disconfirm attempted solutions of problems.**
3. *Understanding:* The perceiving of relationships are emphasised by the Gestalt writers. Problems are to be solved sensibly, structurally, organically, rather than mechanically, stupidly, or by the running off of prior habits. **Insightful learning is thus more typical of appropriately presented learning tasks than is trial and error.**
4. *Transfer:* The Gestalt concept of transfer is transposition. A pattern of dynamic relationships discovered or understood in one situation may be applicable to another. There is something in common not between the earlier learning and the situation in which transfer is found: what exists in common is not identical piecemeal elements but common patterns, configurations or relationships. **One of the advantages of learning by understanding rather than by rote is that understanding is transposable to wider ranges of situations, and less often leads to erroneous applications of old learning.**

5. *Forgetting*: This is related to the course of changes in the *memory trace*⁹. Memory traces may disappear either through gradual decay (a possibility hard to prove or disprove), through destruction (as part of a chaotic, ill-structured field), or through assimilation to new memory processes.

As mentioned earlier, much of the Gestalt Theory was used in the area of problem solving. Eysenck (1990), claimed that Gestalt views problem solving as in the reorganising of a problem and as a search for structural insight, that is, a search for understanding of how all elements in the problem fit to satisfy the requirements of the goal. The major creative act in problem solving is to mentally represent the elements of the problem within the context of the goal. For example, in the six stick problem, problem-solvers are asked to construct four equilateral triangles from six identical match sticks. A solution to this problem is to build a pyramid as shown in figure 4.2.

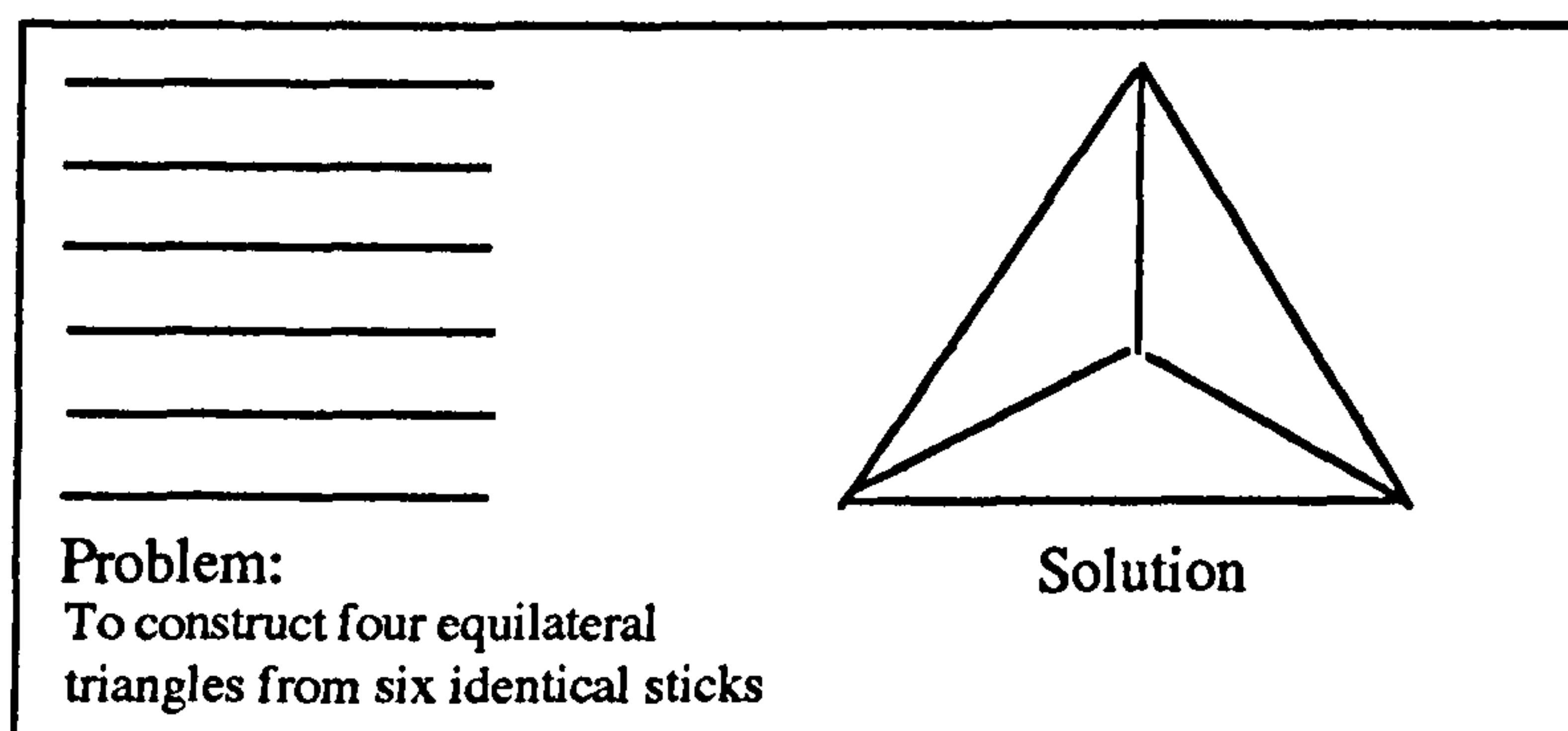


Figure 4.2, to illustrate the act on problem solving using three-dimensional thinking (after Eysenck, (1990): 287) .

The major insights in this problem are recognising that the functional requirements of the goal are such that each stick must be part of two triangles and that to accomplish this, three-dimensional space rather than two dimensional space were used.

The Gestalt psychologists produced several lasting contributions to our understanding of problem solving. These principles could be used to assist the researcher in understanding the problems existing in architectural learning especially in the application of technical subjects like construction technology and structure, which perhaps will allow for creative ideas in design. The principles are classified as follows:

⁹ For further explanation on the concept memory trace please refer to (Hergenhahn and Olson, 1993) pp 268-271

1. Gestalt psychologists distinguished between reproductive thinking (that is, applying pre-existing solution procedures based on past experience to a new problem) and productive thinking (that is, generating a novel solution to a new problem).
2. Gestalt psychologists introduced the trial and error principle or the idea that stages of problem solving involve successive re-formulations of the problems, including increasing more specific representations of the given state and goal state of the problem.
3. Gestalt psychologists provided evidence that past experience (preconceived idea) can create rigidity in problem solving. Lateral thinking is encouraged in this respect.

4.2.3 What is information processing?

Another important development in the study of learning is the information processing model of memory which is based on the idea that the human being is an information processor, that is, he takes the information from the external world through his sensory organs and then applies a mental operation to it and changes it. He then applies another operation to it and changes it again. In such a way, after many manipulations and modifications, the taken information becomes ready to be stored (Mayer, 1981; Biehler and Snowman, 1993).

Perhaps the earliest model of information control was proposed by Broadbent in 1958 (in Kerr, 1982: 161). The model shows how our attention controls and regulates information coming to us. Our sensory organs register so many bits of information momentarily beyond the level that our brain can cope with. However, according to this model, our mind works selectively and omits most of the incoming information. There are several theorists that illustrate the information processing diagrams; for example, Haber and Hersenson (1973), Hirst (1986), Gagne, Briggs et al. (1992) and Hergenhahn and Olson (1993).

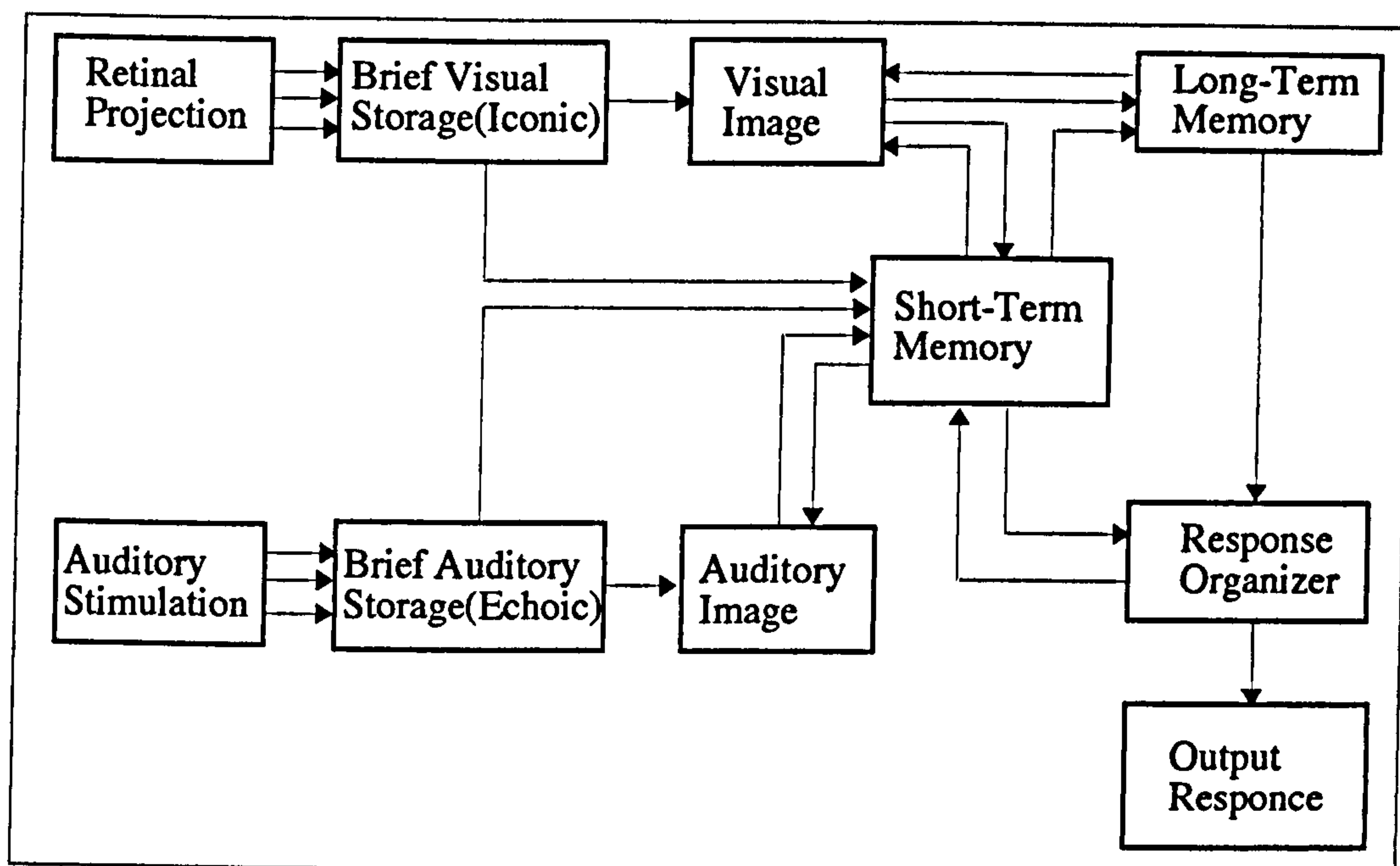


Figure 4.3. The hypothetical model of memory
(Haber and Hershenson, 1973)

This hypothetical model of memory by Haber and Hershenson (1973) shows that man is an information processor. Cognitive understanding of learning is thus a step by step process. According to this model, bits of information go to the *sensory registration*¹⁰ area, that is, retina cells, inner ear, hair cells or other sensory areas. From there, the information will stop in brief visual (iconic) or brief auditory (echoic) storage for a few seconds. Then, the information transforms into visual and auditory images respectively. Next, the images go to the *short-term memory* (STM) by selective perception. From there the information will be processed and will eventually go to the effector organs. If any relevant anchoring idea is readily available in the *long-term memory* (LTM), then this new incoming information will be encoded and stored in the long-term memory. If there is no anchoring idea in the previous knowledge, the information will soon be forgotten. Later when the material has faded from the short-term memory and stored in the long-term memory, if it needs to be recalled, the material would be activated and restored back to the short-term memory before passing to the effector organs for expression.

It can be said that relevant existing ideas play the same role as the sensory receptor cells in the registration area. If receptors are destroyed, no information will go

¹⁰ Sensory registration is the recording of experiences from various stimuli held briefly for possible processing in the sensory register. It is constantly stimulated by visual, auditory, tactile, olfactory, and gustatory stimuli. See (Biehler and Snowman, 1993) page 382.

to the short-term memory, and if there is no previous knowledge, information hardly goes to the long-term memory.

4.2.3.1 Functions of memory

Memory¹¹ is not like a box that we put something into it and remove when needed, nor is it like a magnetic tape where the thing already stored, is read out, although this might be done. Memory encodes, stores and retrieves the entering information (Eysenck, 1990). Encoding means it should be connected with specific (relevant) idea already in the memory. Having come in contact with the previous idea, the learnt material changes and when retrieved is clearly different from the original input.

"The memory system is involved in making sense of the world, in predicting the future and in supplying components to aid in the planning of future action" (Eysenck, 1990).

In the following subsections, two very important contributing factors to the learning domain are discussed. They are the short-term memory (STM) and the long-term memory (LTM) functions.

4.2.3.2 Short-Term Memory (STM)

Short-term memory is also called activated memory. It lasts for seconds or hours and is the ability to recall pieces of information¹², for example, listening to (or seeing) a telephone number and trying to dial it. If there is no special significance it will be forgotten soon after dialing. All differences in capability in learning among the people is due to short term memory difference. This is why some people have difficulty in learning. It is likely that they become overwhelmed by incoming material because they cannot retain the necessary information in mind for a certain time while

¹¹ In psychology, memory is studied as a whole behavior without reference (Squire, 1986), while in neuroscience, it is believed that memory is in the brain at the cellular and molecular level. However, it seems that the following definition is accepted by both sides. Memory is defined as "...the ability to recall thoughts that were originally initiated by incoming sensory signals" See (Guyton 1985 P.348)

¹² According to (Biehler and Snowman, 1993), it can hold about seven unrelated bits of information for approximately twenty seconds - also reported in (Tuckman, 1992) page 192. Dated earlier findings was from (Miller, 1956) in his classic paper "The Magical Number Seven Plus Or Minus Two"

they deal with some learning task (Miller, 1956; Gagne, Briggs et al., 1992; Tuckman, 1992; Biehler and Snowman, 1993). Those who do better perform activities like identifying the inter-relationships of components in items of learning and giving pattern to them. People might not really have short term memory. Performing some activities make them able to retain some learned material for a period of time.

Due to severe limitations of STM, Gagne, Briggs et al. (1992) and Biehler and Snowman (1993) suggested that the problem be dealt through rehearsal, which is divided into two types: the maintenance rehearsal and the elaborative rehearsal. Maintenance rehearsal also known as **rote learning**¹³ or repetition is the act of mental or verbal repetition to hold information for some immediate purposes. Elaborative rehearsal, on the other hand, consciously relates new information to knowledge already stored in LTM (Biehler and Snowman, 1993). In this way it facilitates both the transfer of information to LTM and its maintenance in STM.

An example of this activity is the attempt when to memorise a certain term or phrase by relating it to something familiar. As cited by Rogers (1986) and many other cognitive theorists, mature learners or adult learners don't often employ maintenance rehearsal, but for keeping something momentarily, rote rehearsal is always useful.

4.2.3.3 Long-Term Memory (LTM)

Long-term memory is also called secondary memory. Once long-term memory is established, new experiences are processed and acted on in accordance with them. It can last from days to years, provided it is used frequently. For instance, frequently using a piece of information like one's own phone number, makes it store in long-term memory. Child (1981) said that incoming information which has entered the long-term memory does not decay and seems to stay there permanently because the ideas are in a structural organisation relative to each other. Information will be kept by other established information surrounding it. Most psychologists do not reject the idea that long-term memory also somehow undergoes a kind of forgetting. Our long-term memory does not work like a magnetic tape. In others word it does not follow the law

¹³ The term *rote learning* is widely used in describing learning behaviour during the inquiry and analysis procedure.

of 'all or nothing'. In actual fact, we reproduce the materials selectively. When we forget what is in the long term memory, everything is not lost. The main idea remains in what is called residual memory (Haber and Hershenson, 1973).

The information processing model shown in Biehler and Snowman (1993) (figure 4.4) perhaps most clearly illustrates a simplified version on ways that we process information

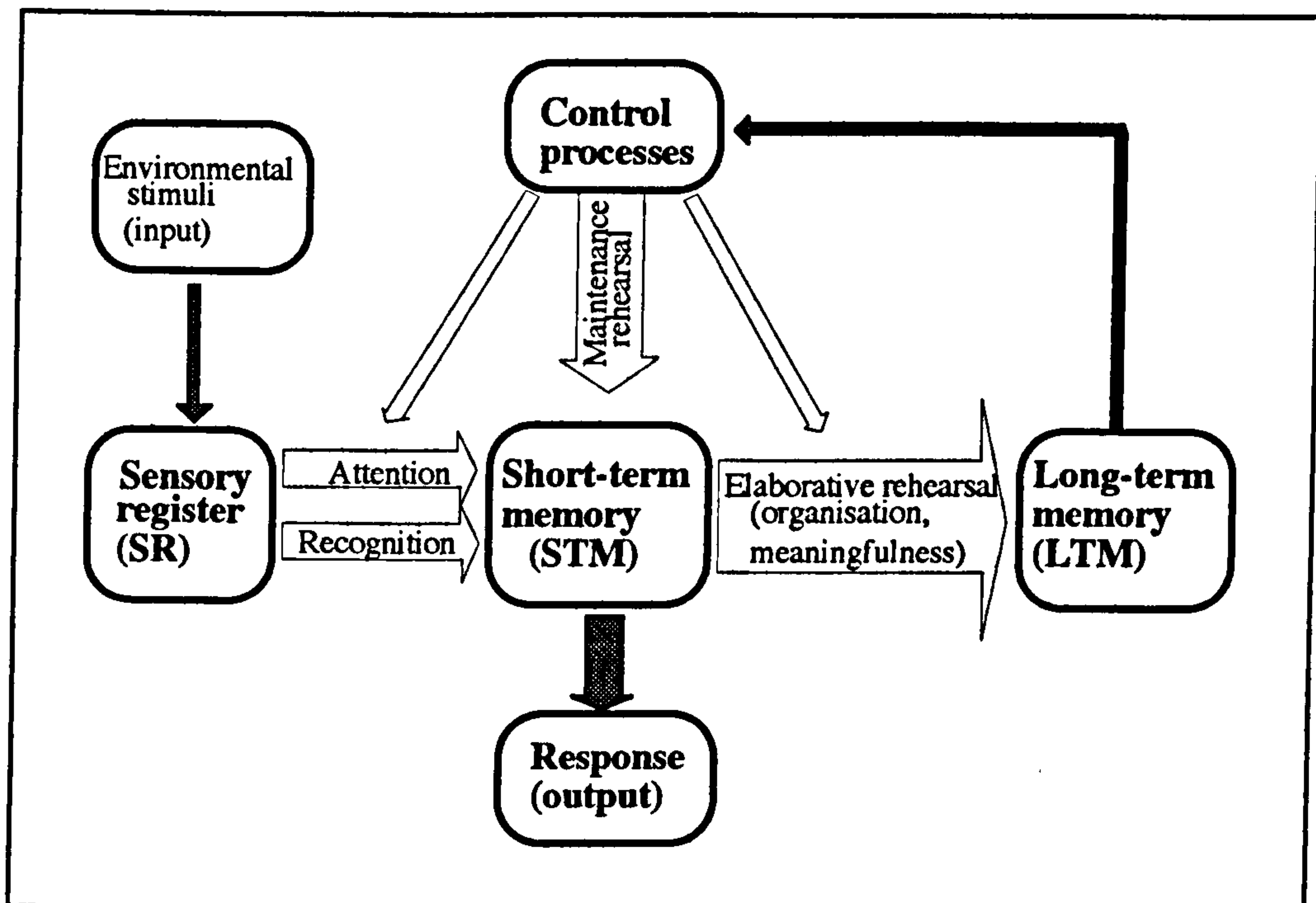


Figure 4.4. An Information Processing Model of Learning (Beihler 1993: 381)

An important difference between short-term and long-term memory is that the latter not only has no limitation in capacity, the more ideas that enter it, the more anchoring areas will be made for new incoming information. Thus, the capacity of long-term memory is progressively increased. Absorption of the newly entered information into a specific anchoring area is called *codification of memories*. In long-term memory the learned material is not stored in random fashion but it activates similar materials already stored. A comparison between old and new then occurs. As a result, a chain of thoughts is made and stored. (Biehler and Snowman, 1993)

A number of factors that lead to long-term storage have been identified. No attempt will be made to go through all of them. Some of the important ones, however, will be discussed here which perhaps would make us understand how the subject could be learn and remembered well.

Some of the cognitive psychologists emphasised the importance of stimulus that are of personal significance. This stimulus like size, colour intensity, novelty, or unexpectedness stand the chance of not only gaining *attention* but being retained in one's memory. This types of stimuli is referred to as '*attention getters*'. There are also devices termed '*mnemonic devices*' or phrases that are used to tie together ideas to remember. The principle behind this idea is that when we learn how things are related, we are able to use one point to help us recall other points. Most of this method is stressed on the memorised items not understanding.

Another way to retain information in the long-term storage and perhaps interest the researcher is summed up in the word '*meaningfulness*' or '*meaningful learning*'. (Johnson, 1975 and Ausubel, Novak et al., 1978). Johnson (1975) concludes that "meaningfulness is potentially the most powerful variable for explaining the learning of complex learning discourse". In defining meaningfulness, Johnson notes:

"learning may be said to be meaningful to the extent that the new learning task can be related to the existing cognitive structure of the learner, that is, the residual of his earliest learning's".

This statement stressed the point that memories are more likely to be retained in one's long-term memory if they can be related to what is familiar or already remembered. This principle is very close to the understanding of **prior learning** by Ausubel, Novak et al. (1978). The contributions of information processing theories to the understanding of learning suggested that learning results from the **interaction between the learner** (the one who processes, or transforms, the information) **and environmental stimulus** (the information that is to be learned).

In a similar situation, Biehler and Snowman, (1993) described four general factors involving in this interaction. They were learners characteristics, learners activities, nature of learning material and nature of the creation. The first two factors concern the learner and the last two concern the task environment.

1. **Learner characteristics.** These pertain to the broad, stable attributes that a learner bring to a task - attributes like prior knowledge, attitudes, motives or objective of learning and cognitive style. Some students may know quite a bit about a subject being studied while others may know very little. Some may show a strong interest in a topic while others would rather study something else. Some may approach tasks impulsively and superficially while others may tackle the same tasks in a deliberate analytical style.

2. **Learner activities.** These concern the kind of mental operations learners employ when presented with a task. In other words, these are the methods used in learning a task. Examples of such activities are note taking during lectures, rehearsing information, generating visual images of facts they want to remember, etc.
3. **Nature of learning materials.** This deals with material presented to students in classroom learning which includes written, linguistic in the form of concrete ideas or abstract.
4. **Nature of the criterion.** This is the manner in which the learner is expected to demonstrate his or her competence. It includes written examination, oral presentation or some motor response. Examinations, for instance, test students on the ability to recall or organise information. Each learning outcome places different demands on a learner. In this research, the researcher calls it learning performance.

Perhaps the most valuable aspect of information processing theory is in the study on the similarities between the behaviour of machine and the behaviour of living organisms. It is now widely recognised that machines can be designed to perform many sorts of tasks previously done by human beings. Stimuli, data, instructions (the generic name is “information”) are input into the machines called computers and the computers would output or read out verified end results. In fact, it might be argued that for computers to be used more effectively in learning, a man-machine symbiosis must be developed in such a way that the machine could support and stimulate creative thinking of the learner. Research undertaken by (Rhu, 1991) illustrated the functional similarities between the computer and the human. It is argued that, with the aid of a proper knowledge base, computers could be used in design thinking.

In general, the contributions of information processing theories in learning domain are widely used in simulation and programmed learning methods for the acquisition of specific tasks like knowledge, psychomotor skills and even problem solving skills.

4.2.4 Organising and retrieving information

Organisation of information as we saw earlier is an important way of approaching or solving a problem. Few experiments were carried out to test this notion by various theorists:

According to Bransford (1979), if we present a list of names of different categories of things for example, humans, animals, trees, vegetables and professions to students in random fashion, and ask them to recall them, they will recall them in categorical series, not randomly. This is called *clustering*. It shows that people use general categories as retrieval cues that help them to recall the acquisition words. For example, Bower, Clark et al. (1969) presented 112 words like *limestone, common, brass, minerals, masonry* to students for recall. The words could be categorised into four general categories (see figure 4.5) but they presented them randomly. They arranged the students in two groups. The first group received all 112 words in four trials and after each trial was told to recall as many words as they could. After the fourth trial, they recalled 65 words. The second group received the words differently. They were presented at first with more general and higher inclusive words in a structurally organised list, that is, in the first trial they were presented with the words in level 1 and 2. In the second trial, they were presented with the words in level 1, 2 and 3, and in the third and fourth trials they were presented with all 112 words. After the fourth trial, the students in group 2, remembered an average of 100 words (compared to 65 from group 1).

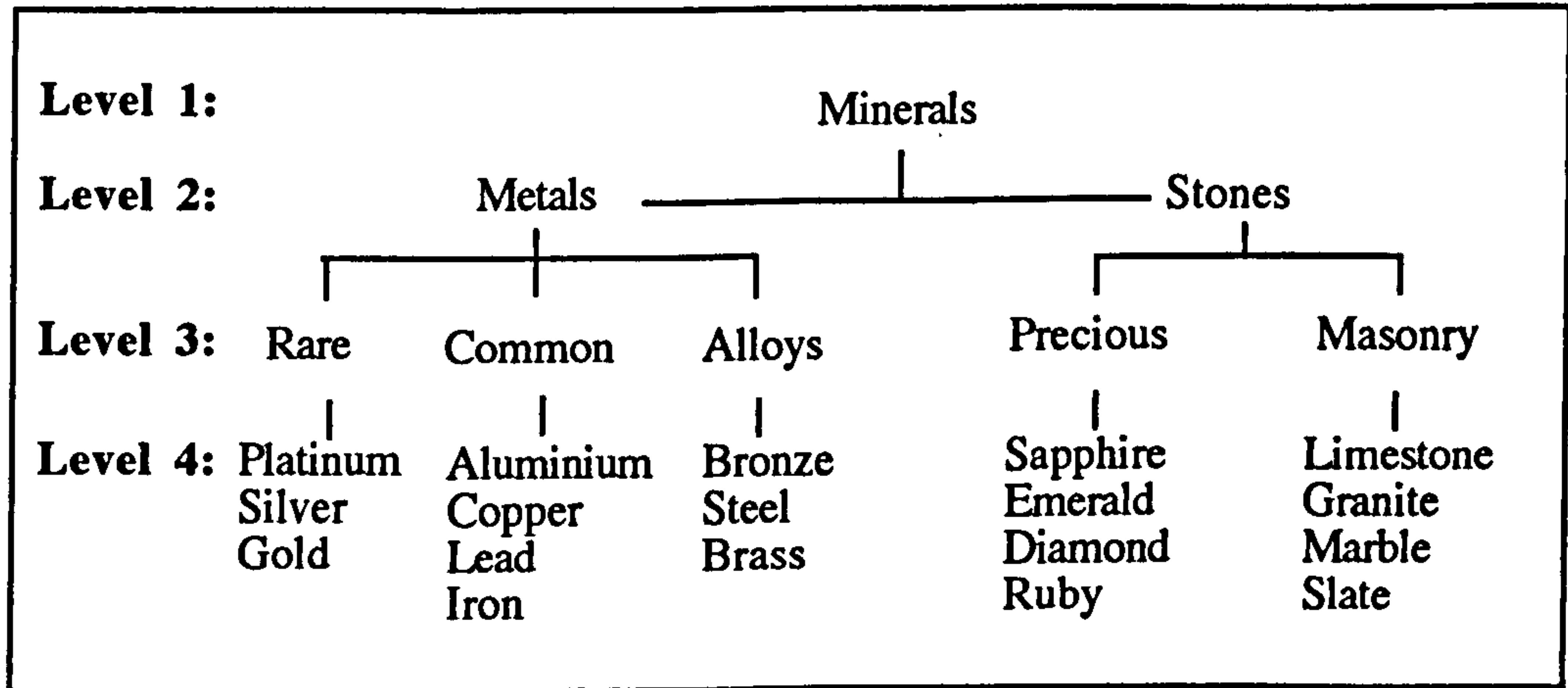


Figure 4.5: An example of categorisation arrangement (Bower, Clark et al., 1969 in Biehler and Snowman, 1993: 386)

4.2.5 Verbal and non-verbal communication

According to Ausubel (1968) - an educational psychologist whose work was mainly on classroom learning - learning and teaching is nothing more than acquisition and transferring of meanings. The words are used as vectors of these meanings from one person to others. The knowledge we obtain through words both visually (reading) and auditory (listening) is called *verbal knowledge*. Thus, when this action (reading or listening to the recognised words) takes place, meaningful learning has occurred. In contrast, dealing with the words as some empty container (non-recognised words or sense-less syllables), is called *verbatim*. Verbatim has a *rote* nature and cannot actually be meaningful.

"Cognitive theory regards the human nervous system as a data-processing and storing mechanism so constructed that new ideas and information can be **meaningfully** learned and retained only to the extent that they are relatable to already available concepts or propositions which provide ideational anchorage" (Ausubel, 1968: 21)

Transferring information through gesture or seeing happiness or sadness in the faces of people and pantomime are common examples of non-verbal communication. It is believed that sometimes gestures are more meaningful and accurate than the spoken words with them (Child, 1981). It is quite possible to notice that the implicit meaning of gestures are in conflict with the explicit message of a verbal communication, for example, when somebody lies and you read it in his face and voice (same ref.).

However, in the classroom "*non-verbal*" learning is the kind of learning in which acquisition takes place by problem-solving and discussion methods rather than by directly delivering the content of the subject-matter to the students (Ausubel, 1968).

4.2.6 Rote versus meaningful learning

Ausubel, unlike many other psychologists and educationalists, did not pay much attention to what short and long memories are or how to do feats of memory. He dealt with the realities in learning problems in society. He constructed a differentiated classification for all types of learning. He explained:

"The most significant way of differentiating among these types of classroom learning is to make two crucial process distinctions, that cut across all of them, one distinction between *reception* and *discovery learning* and another between *rote* and *meaningful learning*. The first distinction is significant because most of the understandings that learners acquire both in and out of school are presented rather than discovered. And since most learning material is presented verbally it is equally important to appreciate that verbal reception learning is not necessarily rote in character and can be meaningful without prior non-verbal or problem solving experience" (Ausubel, 1968: 21).

He distinguished two very common attributes of all types of learning, that is **meaningfulness** and **roteness**, to determining factors in the success or failure of most learning tasks, Ausubel, Novak et al. (1978) defines meaningful learning as:

"A learning task can be related in a non-arbitrary, substantive (non-verbatim) fashion to what the learner already knows, and if the learner adopts a corresponding learning set to do so" (Ausubel, Novak et al., 1978: 27).

By non-arbitrary he means 'inherently' or linked that is having a plausible basis for relationship. By substantive or non-verbatim, he means 'independent of particular wording'. Therefore, a substantive attribute shows content of a verbal task (meaning) while, a verbatim attribute shows morphology of the verbal task. By learning set, he means (in this context) prior learning (Ausubel, Novak et al., 1978).

Ausubel, Novak et al. (1978) further gives an example of *meaningful learning*. A student learns Ohm's law which indicates that the current in a circuit is directly proportional to the voltage but this proposition will not be meaningful until the student knows the meaning of the concepts of current, voltage, resistance, direct and inverse proportion. All these are necessary prior knowledge for learning Ohm's law meaningfully. *Rote learning*, on the other hand, occurs when:

"A learning task consists of purely arbitrary associations, as in paired-associate, puzzle box, maze, or serial learning. The learner lacks the relevant prior knowledge necessary for making the learning task potentially meaningful..." (Ausubel, Novak et al., 1978: 27) .

This part of Ausubel's theory is summarised in table 4.1

Table 4.1. Conditions of meaningful learning (Ausubel, Novak et al., 1978) .

LEARNING	ROTE	MEANINGFUL
Prior knowledge	no or irrelevant	relevant
Kind of linkage	arbitrary	non-arbitrary
Taken knowledge	morphology (wording shell)	meaning (content)

4.2.7 Reception versus discovery learning

In reception learning (rote or meaningful) the principal content of learning material is presented to the learner almost in the final form. On the contrary, in discovery learning, whether concept formation or rote problem-solving, the principal content of what is to be learned is not given but must be discovered by the learner. Again, Ausubel (1968) argues with those authors who consider reception learning as a rote old-fashioned way of learning. He says we cannot ignore this reality that in any culture reception learning is the most common form of classroom learning. Besides that, reception learning could be meaningful as well as discovery learning which also may or may not be meaningful.

Discovery learning has two phases. The first phase is completely different from the reception learning as was explained above, but the second phase is that, when discovered material is obtained, it is not necessarily meaningful. Going through a maze to reach the response in a mathematical problem may be the same as trial and error learning. So after finding the response, **it should be made meaningful, in the same way that presented material is made meaningful in the reception learning.** In discovery learning, it is **previous knowledge** (sometimes called existing knowledge) that should be understood before further learning takes place (Ausubel, 1968).

4.3 Experiential learning

Little seems to have been written on experiential learning as such. There is still confusion as to its real meaning and the term itself. A scan of the literature on this subject confirms that this is how the term '*experiential*' has been applied. Wright (1970) defined 'experiential learning' in terms of a model:

"(Experiential learning) begins with the experience followed by reflection, discussion, analysis and evaluation of the experience. The assumption is that we seldom learn from experience unless we assess the experience, assigning our own meaning in terms of our own goals, aims, ambitions and expectations" (Wright, 1970: 234)

The main issue was the process of assigning our own meaning. Wright continued,

“...the insight, the discoveries, and understanding. The pieces fall into place, and the experience takes on added meaning in relation to other experiences. All this is conceptualised, synthesised and integrated into the individual's system of constructs which he imposes on the world, through which he views, perceives, categorises, evaluates and seeks experience”.(Wright, 1970: 234).

Kolb, Rubin et al. (1971) and Kolb (1984) described experiential learning as a process in which a particular experience is translated into concepts which in turn becomes guidelines for new experiences. In his contribution to the theory of experiential learning, he assigned four stages of experiential learning namely:

1. Concrete Experience(CE) of a learning situation,
2. Reflective Observation (RO) of relevant phenomena,
3. Abstract Conceptualisation (AC) about the meaning of what has been observed and,
4. Active Experimentation (AE) which is the testing of hypothesis relative to what has been experienced, observed and conceptualised as being pertinent to a learning situation.

Based on these principles, it followed that for learning to be effective, the learner needs four different abilities. For the learner to be involved fully, openly, and without bias in new experiences, the learner should be able to reflect on and observe these experiences from many perspectives. He should be able to create concepts that harmonise his observations into logically sound theories and should be able to use these theories to make decisions and solve problems.

Although it is quite important to study details of this theory in this thesis, what seems more important is to understand the concept of how meaningful learning is derived in experiential learning. However, what is not clear is the nature of the ‘experience’ which is used as the focus for this insight-generating process. To some writers, these experiences could be transmitted through simulations such as learning games and exercises.

Kolb, Rubin et al. (1971) translated their model from a humanistic viewpoint. They took ‘experience’ to mean everything that happens to a person. Like Wexler (1974) took a slightly different view of experience. Rather than seeing it as something

that happens, from which one may or may not derive insights, he defined it as the insight-gaining process:

“Experience is not something already existing, to be open to, but is what is created by the functioning of cognitive processes. It is the activity of attending to and organising information that enables us to make sense out of our world, and it is this activity, we call experiencing” (Wexler, 1974).

Therefore, experiential learning involves not only learning by doing but also learning through applying, feedback, review and reflection. Throughout our lives, learning takes place all the time as a result of our experiences. Most of what we learn comes from doing, looking and criticising the previous experience and applying it to the new subject.

Leinhardt, McCarthy Young et al. (1995) stressed on the fusion of experience and theory in the structure of professional education such as in the school of architecture, engineering, medicine and teaching. In their paper on the issue of integrating professional knowledge, they argued that:

“Instructional practices tended to be authentic and specific and were typically marked by 'schools' of action and thought. The learning of professional knowledge in these settings meant acquiring procedural knowledge and pragmatic aspects of the practice, and was demonstrated by being able to perform the practice and produce its products” (Leinhardt, McCarthy Young et al., 1995: 401)

In general terms, experiential learning is synonymous with meaningful-discovery learning. This is learning which involves the learner in sorting things out for himself, by restructuring his perceptions of what is happening.

4.4 Motivation

Motivation has been stated and implied in all the learning theories mentioned above according to the bases of each learning theory. Most of the conceptions of motivation that has been discussed can be classified as expectancy or performance oriented because they described what people expect to get for putting out a certain amount of effort. For example, operant conditioning (S-R) and social learning theory suggest that people will work to achieve a goal if they expect to receive an appropriate

reward. Likewise, humanistic theory holds that people will strive towards self-actualisation (Maslow, 1987)¹⁴ if they expect their deficiency to be met. (please refer to table 4.2)

School of Thought	Views on Motivation
The Behavioural theorist	Stressed that the individual is motivated when his behaviour is reinforced . They urged the teacher to reinforce students with praise and rewards of various kinds when correct answers or responses occurs.
The cognitive theorist	Stressed that the individual is motivated when he experiences a cognitive disequilibrium or a desire to find information or solutions - whereby learning occurs for its own sake . Unfortunately, it is difficult to arouse a cognitive disequilibrium in all, or even most students.
The humanistic (not discussed in detailed here) under psychologist Abraham Maslow	Proposed that human needs are arranged in hierarchical order. Deficiency needs (physiological, safety, belongingness and love, and self esteem) must be satisfied before the growth-motivated person engages in self-directed learning.

Table 4.2. Motivation according to bases of each learning theory

Findings from Brophy's (1983a; 1983b) work on students' performance showed that motivation is likely to be optimal when students know they have the skills to master a task and value those skills. Thus, success experiences, achievement motives or reward will not simulate the best motivation for classroom learning. In fact, in the adult learning study by Knowles (1970) and Rogers (1986), they focused on the value of learning for its own sake.

4.5 Cognitive learning styles

Another aspect of learning that needs to be looked into is cognitive learning styles. The distinction of these learning styles, identified in several psychological

¹⁴ Maslow's theory of hierarchy needs has been widely applied in many studies besides education. The theory base on the five-level hierarchy needs which are: physiological, safety, belonging and love, esteem and the top most self-actualisation. According to the theory man will constantly strive to satisfy these needs, until they reach the top of the hierarchy which is the self actualisation stage, which is also refer to as the self-fulfillment stage. This stage varies from one person to another. For further reading see (Maslow, 1987)

experiments, tend to show similar features within the same group . These styles are classified into two main groups. The first group tend to work with the elements of the problem within their context through small logical and sequential steps, using deductive and interpolative skills, and usually seeking to arrive at one correct solution. In contrast, the second group inclined to work with the problem by getting bits of information not necessarily connected in a sequential and logical way. They were not confined to the problem context and they dealt best with problems presenting a wide range of solutions. The groups are presented below:

Group One	Group Two
Convergent	Divergent
Sequential	Parallel
Serialist	Holist
Rational	Intuitive
Impulsive	Reflective
Field Dependent	Field Independent

Table 4.3: Classification of cognitive learning styles

The importance of recognising the differences in cognitive styles is in matching the learner's learning style to the teaching style. Teachers, as well as students, have different cognitive styles, and so styles of teaching may vary much as styles of learning. Cognitive learning styles have been studied by many psychology researchers including Pask (1976; 1985), Lawson (1979; 1990), Ford (1985), and Entwistle (1988). Learning in matched condition (in which instructional style is matched with students' preferred learning styles) has been demonstrated to be significantly more effective than learning in mismatched conditions

Cross (1985) referred to several psychological studies showing the importance of matching the learners cognitive styles with teaching styles in order to optimise performance in the learning/teaching task. The results of these studies are reported below.

1. The results of studies conducted by Pask in 1972, on 'Serialist' and 'Holist' cognitive styles, showed that the least successful student among those who had their cognitive style matched with the teaching strategy, tended to perform better than even

the best mismatched student. According to the results, the matched students also had a significantly greater ability to generalise from the knowledge acquired. The matching of cognitive learning style with teaching style, therefore, has great significance.

2. Another study by Hudson (1966) was made between the 'convergent' and 'divergent' thinking. Convergent thinking is primarily concerned with taking in information and converging on one correct answer to the problem. The opposite is done in the case of the divergent. Here the emphasis is on the ability to generate a wide range of possible answers. From the experiment, Hudson not only conclusively stated that the 'arts' students are likely to be 'divergers' and the 'science' students are likely to be 'convergers', but, he also concluded that the teaching strategies used in mathematics, science and technology are characterised by logical, structured presentation which encourage convergent thinking, while teaching strategies in the art and design, provide area of interest to generate project base, which encouraged divergent thinking. Results of the study from Hudson indicated that divergent learners learn best from divergent styles of teaching and vice versa.

3. A Study from Witkin (1969) was on cognitive style of 'field dependence' and 'field independence'. The study reported that people differed from each other in the way they perceive the domain of the problems and themselves. Watkin used the concept of 'field dependence' to characterise the person who is influenced by the domain and 'field independence' to describe the person who is free from it. He demonstrated that people with field independence perform much better than field dependent people when facing problems in which there was a need for imagining the problem in a different context.

To sum up, learning would be significantly better in matched condition than in mismatched conditions. Therefore, it can be concluded that **matching of cognitive styles between learners and teachers (humans, books of instruction, computer systems or any facility capable of performing the teaching task of conveying information) is vital** to the success of any programme that aims to convey information to be learned.

4.6 Summary

Looking closely at the two approaches, behaviourism and cognitivism, it is obvious that both would have different stances to the conduct of the learning-teaching process. Teachers have often alleged that the behavioural theory emphasises external control in learning, while cognition places premium on intrinsic motivation. The former (i.e. behaviourism) is often labelled 'subject-centred' while the latter (i.e. cognitionism) is said to be 'learner-centred'.

Cognitionism proposes different memories, of which long-term memory is the point that we should concentrate on. Three important factors involved in long-term retention that must be included in any learning task. They are:

1. Providing high motivation,
2. A functional and practical approach, and
3. Visual learning through the arranging intentional instruction instead of incidental learning

High motivation - High motivation can be induced onto the individual when he experiences a cognitive disequilibrium or a desire to find information or solutions in an intrinsic form of motivation where learning occurs for its own sake. This notion is more appropriate for the objective of the study as this object (the students) in this case are adult learners. They usually come to the higher education with ample motivation.

Even though criticized by authors like Rathus (1988) and Biehler and Snowman (1993) on the limitation of cognitive theory as stated by (Biehler and Snowman, 1993) "some pupils may experience a feeling of curiosity and be eager to clarify their thinking but others may stare out of the window or do other works". In the case of higher learning the motivation factor is more likely driven by cognitive rather than physiology (Rogers, 1986).

A functional approach to learning material - This approach has a strong effect in the transfer of information to long-term memory because it combines a practical approach with the learner's experience forming part of everyday life. Associating new information like construction technique with a familiar building will create a meaningful and deep understanding in the subject matter. In comprehensive learning, there is a big difference between actions of simple objects like household objects and complex actions like complex building structures. Learning the latter requires sound training and a practical approach.

Visual Learning through Intentional Instruction - Gestalt theory gives us a good idea about how we perceive the external environment and how we can avoid being overwhelmed with a mass of information, on one hand, and how we can avoid reception pitfalls on the other. Organisation of information as we saw earlier is an important way of approaching or solving a problem in Gestalt Psychology. All of these give us principles for pattern learning. Gestalt theory, exceptionally has a good application in human perception especially dealing with visually oriented learners. By using Gestalt Psychology the learner can see and relate an idea from two dimensional sections to a three dimensional image in the design. The Gestalt-oriented teacher might use the lecture technique but would insist that it allows for student-teacher interactions (Hergenhahn and Olson, 1993). Above all, rote memorisation of facts and rules would be avoided. It would stress on the principles involved in the learning experience that students truly understand. When what is learned is understood instead of memorised, it lends application to new situations. It is also retained for a very long time. In order to gain understanding, the learning task has to be meaningful and relate to prior knowledge.

In order to link between knowledge and the thinking process, students are encouraged to pose questions cognitively while learning. This technique allows learners to recognise gaps in their thinking which they can then clarify. This technique is recommended by Jerome Bruner for structuring discovery learning and by Jean Piaget in supporting his principles of equilibration, assimilation and accommodation (Biehler and Snowman, 1993):

"A sense of equilibration may be experienced if a child assimilates a new experience by relating it to an existing scheme or the child may accommodate by modifying an existing one" (Biehler and Snowman, 1993: 514)

Those eager to connect this gap are not driven by their physiological drives but by curiosity, an urge to explore, or simply an impulse to try something for the fun of it. This according to cognitive theories is intrinsic motivation (Biehler and Snowman, 1993: 515) . It is important to remember that what has been learnt has been selected from problems of personal concern or from personal interest and because of this it is likely to be benefit from and well remembered. A worked example on this was carried out by Reno (1992) on the principle of constructivism using Iakov Chernikhov theory of constructivism. Even though this has a lot to do with experiential learning, it

explains clearly how the gap existing in the thinking can be eliminated by intrinsic learning motivation of the students.

The discussion in this chapter may enable us to make the following conclusions on factors influencing the process of acquiring knowledge (these factors are used as variables in the hypotheses testings which are discussed in detail in chapter 7):

1. **Active (not passive) interaction with the learning environment** is useful in the process of acquiring knowledge;
2. **Individual differences in learning** (for example styles of learning and differences in deep or surface approaches to learning) contributes to the different performance in learning;
3. **Prior knowledge plays an important role in learning** whereby new knowledge and skills build upon experience contribute to better understanding;
4. **Anchoring learning in real life context are important** (connecting classroom knowledge to real life experiences); and
5. **Communication and interaction** among learners and learners, learners and teachers, and learners and learning environment are vital

Since the subject construction technology deals with a mass of information (which keep on changing with time) it need to be emphasise on good quality expository teaching. The information (in lecture, reading passage, or even a computer aided learning material, for example) should be organised and presented in a way that it can be easily related to students' existing knowledge (prior knowledge) or would explain how they are related to the whole design intention¹⁵.

¹⁵ Design intention can be extended further to the reason "why" such and such intention is carried out. It can be explained in terms of its functional, aesthetic, social, economic or even political reasons.

Chapter 5

Research Design And Methodology

5.0 Introduction

Research planning is a very important part of the whole research process since choosing the appropriate method and approach is the most important aspect in determining the data obtained and, the findings of the research itself. This chapter discusses the central aspects of the research methodology used in this study. In general, there are nine aspects namely:

1. Research methodology overview
2. Research framework and formulation of hypotheses
3. Research design
4. Survey research
5. Sampling procedure
6. Questionnaire
7. Data analysis techniques
8. Limitations of methodology

Apart from the above this chapter also covers areas such as the data collection experience, process and the discrepancy in the field work undertaken. Finally, it will also highlight the techniques adopted in data processing and analysis.

5.1 Research methodology overview

5.1.1 Defining research

There are many definitions of research. One workable example defined by Nachmias and Nachmias (1996) is research is a systematic and organised effort to investigate a specific problem that needs a solution. Research can also be defined as a systematic, and careful inquiry or examination to discover new information or relationships, and to expand or verify existing knowledge for some specific purpose (Linn and Erickson, 1990). Collins English Dictionary (1994) defines research as:

“A systematic investigation to establish facts or principles or to collect information on a subject aimed at:

- discovery of new facts and their correct interpretation
- revision of accepted conclusions, theories, or laws in the light of newly discovered facts, or
- practical application of such new or revised conclusions, theories or laws.”

Research can be classified by different aspects, such as the field of study, the purpose of the work, the approach taken and the general nature of the research. Linn and Erickson (1990) classified research into what they call the common classification: (a) to review existing knowledge, (b) to describe some situation or problem, (c) to construct something new, and (d) to explain. Hakim (1989) classified them into four categories : descriptive research, experimental research, historical research and philosophical research.

Along the same line, Borg and Gall (1983) specify the types of research which they call the traditional classification as:

- a) Basic/pure/theoretical/fundamental
 - discovery of new theory - not easy; needs ingenuity, imagination and perseverance
 - Development of existing theory - improvement by:
 - i relaxing some assumptions
 - ii reinterpreting the theory
 - iii extension

- b) Applied research
 - apply known theories and models to practical problems
 - tests empirical content of a theory
 - tests basic assumptions

However, most research on education classify research into two major categories: qualitative and quantitative research (e.g. Borg and Gall (1983); Bryman (1990); Light, Singer et al. (1990); Linn and Erickson (1990)). According to the kind of data collected, Bryman (1990) and Burgess (1994) define qualitative methods as an array of interpretative techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world. Strauss and Corbin (1990) (p. 17) define qualitative research as “any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification”. The most fundamental of all qualitative methods is that of in-depth interviewing (Strauss and Corbin, 1990) and the other are observation and diary methods. According to Nachmias and Nachmias (1996), there are two types of qualitative research: group discussions and depth interviews. The key difference between them is that depth interviews are on a one-to-one basis between researcher and respondent and group discussions involve several respondents together with the researcher in the same place at the same time.

Four major components to the collection of qualitative data have been described by Nachmias and Nachmias (1996) as:

1. The researcher must be able to get close to the people or situation at the centre of the study;
2. He must record accurately what is said, actions and exactly what happens;
3. He must be able to give pure descriptions of people, activities and interactions; and
4. The data should consist of direct quotations.

Therefore, qualitative research seeks to understand an event or action by using the respondent's own words and behaviour. Nachmias and Nachmias (1996) discussed the advantages of unstructured interviews (open-ended questions), which are believed to be more flexible, as fewer restrictions are placed on respondents' answers compared with structured or semi-structured interviews. They claimed that in an unstructured interview, one can gain an insight into the character and intensity of a respondent's attitudes, feelings, preferences, underlying motivations and unacknowledged attitudes. The term '*probes*' in the interviews were used primarily to

motivate the respondents to elaborate on or clarify an answer or to explain the reason behind the answer and they help focus the conversation on the specific topic of the interview.

On the other hand, quantitative research is geared primarily to the collection of quantitative data, which is expressed as numbers (Linn and Erickson, 1990). One important feature of this research is that the process of data collection becomes distinct from analysis (Nachmias and Nachmias, 1996). Most of them involve formal questionnaire technique such as face-to-face interviews, telephone interviews, postal research, or various forms of experimental or quasi-experimental research (Nachmias and Nachmias, 1996). According to Linn and Erickson (1990), the quantitative methods have a dual role. The first role is to describe a relationship in a way that can make understanding easier (the modelling role), the second is to assess the strength and validity of any relationship defined (the testing role). Whereas, Bryman (1990) concludes that in good research, good quantitative analysis has a relatively limited role. In conclusion, this approach is best suited where the aim of the study is to determine how many, what, when and where. Table 5.1 below summarises the differences between these two approaches.

Table 5.1. Differences Between Qualitative and Quantitative Research.

	Qualitative	Quantitative
Sample size	Small, typically less 100	Large, hundreds or thousands
Questioning	Follows the respondent's reactions to set stimuli within a general framework	Follows a set format and is the same for each respondent.
Objectives	An expansion of existing data	A refinement of existing data (How many? When? Where?)
Analysis	Contents	Statistical
Report	Written for the purpose of understanding the attitude and behaviour of respondents.	Based on statistical summaries and correlation

Source: (Moser and Kalton, 1985)

There are advocates for each of the approaches, each trying to claim that their approach is superior to the other. For example, the supporters of the qualitative approach claim that the mere use of statistical techniques does not ensure rigor and objectivity, and often, quantitative researchers are required to make qualitative judgements in order to determine their analysis categories. Quantitative researchers argue that their approach is systematic rather than impressionistic, so that individual exceptional items do not gain an importance out of proportion to their real value. It is however on the issue of the reliability of qualitative results that quantitative researchers are most critical. They argue that the use of judgement can lead to circularity, that is, the study finds what it wanted to find.

The conflict between these two schools of thought is best summarised by Bryman (1990) who states:

“Quantitative researchers demand that data should be objective, non-reactive, representative, and should be collected using standard measures. They reject qualitative research as subjective, unrepresentative, unsystematic, and inconclusive. (Many would however accept the fact that it is very useful for exploratory phases of quantitative research projects). Qualitative researchers might counter that an individual's behaviour can only be understood if that individual's perspective is known and understood in context, and that quantitative research is artificially shallow and misleadingly scientific”.

(Bryman 1990)

Another important point to note is that most data gathering procedures for quantitative research are usually highly structured and standardised so as to enable the responses to be statistically analysed, whereas qualitative studies do not have such strict requirements. In this study, the two approaches were employed at different stages and to different degrees.

The reason for combining qualitative and quantitative methods for this research is to supplement and to overcome methodological weaknesses of one method only. Since qualitative and quantitative methods often have different biases, each can be used to check the other¹⁶. This combination of methods might also help the researcher to obtain a reasonably representative sample and a rounded understanding of that sample.

¹⁶ See Denzin (1970) on “triangulation”.

5.2 Research framework and formulation of hypotheses

Based on an extensive review of the relevant literature, the conceptual model below was developed (refer to figure 5.1). In summary, the researcher suggests that effective learning and teaching methods will influence the performance of the students. However, these two factors are duly influenced by three groups of potential variables: the learning method adopted by the students, the prior knowledge (the experience) of the students and the teaching methods employed.

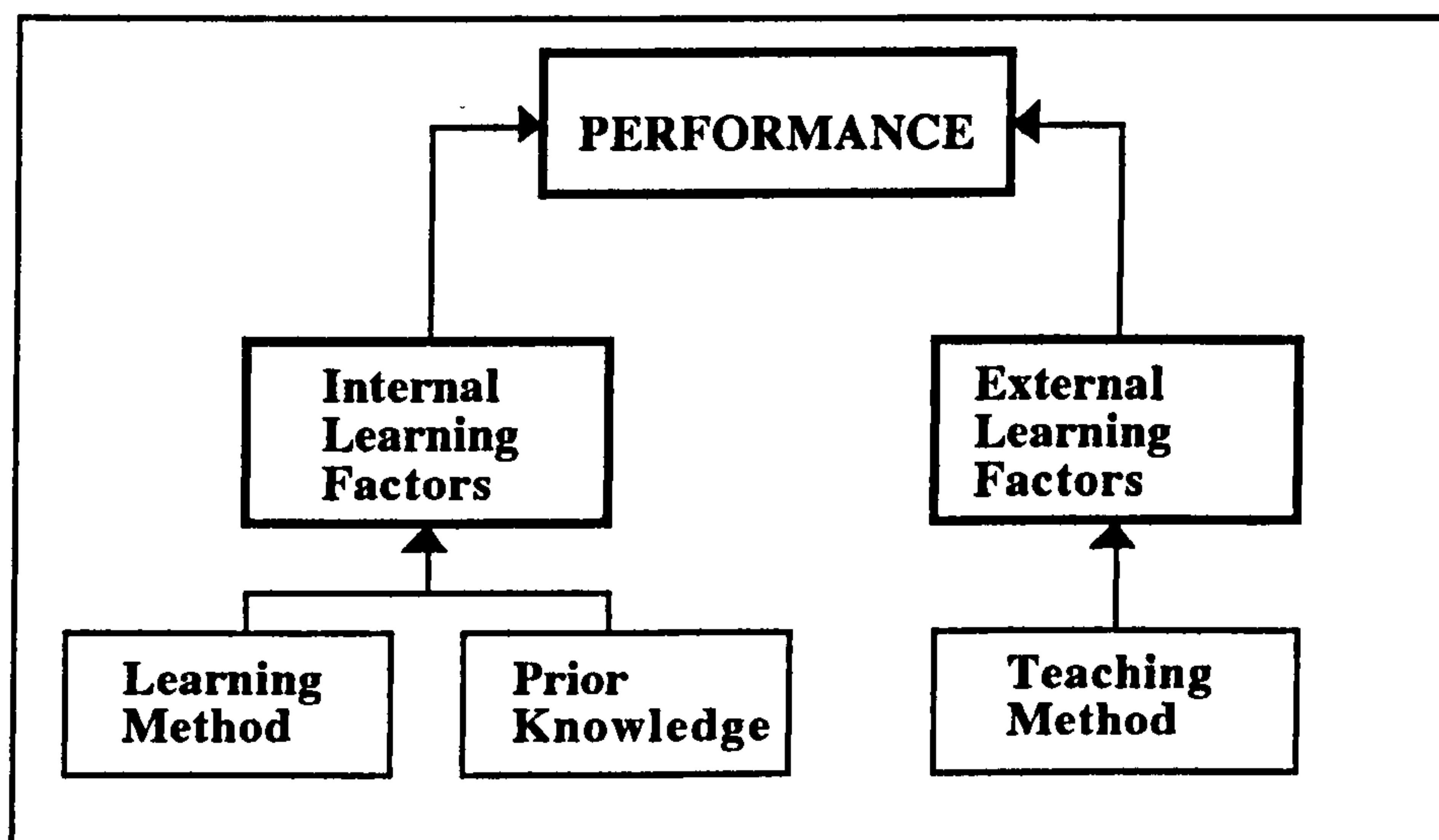


Figure 5.1 Conceptual Model of Research Framework (Source: Author)

5.2.1 Internal learning factor: The learning method adopted

Research on learning methods pertaining to architectural students have been and are continuously receiving a considerable amount of attention from researchers (Lawson, 1975; Lawson, 1979; Peters, 1986; Fowles, 1990; Abu Bakar, 1992; Rambow, 1995). The general background on how the students learn (for example, whether they do rote learning, having informal discussion, visual oriented, etc.) is an important criteria in understanding construction technology.

However, in relation to the design process, it is important to investigate how well the students integrate the theoretical aspects of construction knowledge into design, through their method of studying, objectives of studying, designing behaviour and motivation. In addition, time management is also included not as a learning factor

but as an outcome of the situation. In short, the differences in their learning methods may affect the performance of the students. Consequently, each and every one of the learning methods will be tested against a student's level of understanding construction technology. Therefore, in this study the researcher hypothesises:

HYPOTHESIS (1) :

There is a significant difference in the adopted learning method between students who are knowledgeable in construction technology and students who are facing difficulties in understanding construction technology.

5.2.2 Prior knowledge

Prior knowledge in this study refers to the practical training received by the students, work experience and years of studying in the architectural domains. Allen (1980), Albrecht (1988), Achtenhagen (1995) and Avis (1995) foresee the advantages of having adequate prior knowledge which may reflect the higher ability to visualise and rationalise, the workability and feasibility of the building designed, better problem solving skills and speed in decision making, which in turn affects the overall performance of the students. In fact, Hegvold (1993) stressed that, it is the role of the lecturers to bring out these intrinsic qualities of their students and to induce this knowledge and not to impose. In this study the researcher hypothesises:

HYPOTHESIS (2):

Prior knowledge of the student correlates positively to learning performance.

In order to prove this hypothesis, four sub-hypotheses were presented:

- H2(a) Educational background (previous experience in construction) is positively correlated with better understanding in construction technology;
- H2(b) Educational background (previous experience in construction) is positively correlated with competency in construction technology;
- H2(c) The length of years studying the subject is positively correlated with better understanding in construction technology;
- H2(d) The length of years studying the subject is positively correlated with competency in construction technology.

5.2.3 External learning factor: Teaching method

Various studies on teaching and learning methods show the importance of matching the learner's cognitive learning style with teaching styles in order to optimise performance (Pask, 1976; Cross, 1985; Ford, 1985; Pask, 1985; Ford, 1995). Despite a lack of empirical evidence from architectural schools on this issue, the researcher would expect that learning would be significantly better in a matched condition (in which instructional styles are matched with students' preferred learning styles) than in a mismatched one. Hence, the hypothesis:

HYPOTHESIS 3 (H3)

There is a mismatch between the preferred learning method and the teaching method on the subject construction technology in the architectural learning system.

5.2.4 Performance

The practice of evaluation on students' performance is vital in learning and teaching assessment in which a judgement about the value or worth of the thing or knowledge is made (Gronlund and Linn, 1990). Biehler and Snowman (1993: 565) defined performance as "the measures that attempt to assess how well somebody can do something in accordance to the objective/s of the learning material which may focus on a process (*knowing how to do something*), a product (*knowing about something*) or both under realistic condition". In this study, the student is said to perform well when he is:

1. able to think constructional elements and design factors concurrently;
2. able to relate construction concepts, process involved and practical implementation into the design process;
3. able to perceive construction as an important design generator;
4. able to accept construction as a major element of the whole body of design;
5. confident in design; and
6. show good design results.

For the benefit of this research, we hypothesise that:

HYPOTHESIS 4 (H4)

Understanding construction technology is positively correlated with performance in the design process.

In order to prove this hypothesis, six sub-hypotheses were presented:

- H4(a) Understanding construction technology is positively correlated with confidence in design;
- H4(b) Understanding construction technology is positively correlated with the ability to think construction and design (theory and practical) concurrently;
- H4(c) Understanding construction technology is positively correlated with the ability to relate construction method into design;
- H4(d) Understanding construction technology is positively correlated with the perception that it is an important factor in design and can be used as a design generator;
- H4(e) Understanding construction technology is positively correlated with the perception that it is one of the major element of the whole body of design;
- H4(f) Understanding construction technology is positively correlated with superior design result,

5.3 Research design

One of the preliminary steps in conducting a research project is to develop a research design which may be defined as the basic plan or framework which guides the researcher in collecting and analysing the necessary data. "It is the blueprint that enables the investigator to come out with solutions to research problems and guides him or her in the various stages of the research" (Nachmias and Nachmias, 1996 p.99). In this section major research designs namely, exploratory, descriptive and causal researches are explained. Unfortunately there is no single, standard or idealised method of carrying out research in this area/field (Borg and Gall, 1983; Hakim, 1989; Light, Singer et al., 1990; Nachmias and Nachmias, 1996). Therefore, a researcher should choose an appropriate research design that best suits his objectives, data requirements and available resources.

5.3.1 Exploratory research

The major emphasis in exploratory research is on the discovery of “ideas and insights”. Although exploratory research is the initial objective of this research, it can also be used judiciously with other research methods such as descriptive study. The exploratory research method is characterised by a *“high degree of flexibility with respect to the method used for gaining insight and developing hypotheses”* (Hakim, 1989). Exploratory research rarely relies on structured data collection instruments or involves any form of probability sampling procedures, rather, literature surveys, experience surveys, focus groups and the analysis of selected cases are more productive in exploratory research. Experience surveys attempt to tap the knowledge and experience of those familiar with the general subject being investigated, while focus groups are another tool for gathering the required data. This method involves an objective discussion leader who introduces a topic to a group of respondents and directs their discussion of it in a non-structured and natural fashion. Nachmias and Nachmias, (1996: 234) list the following purposes for the exploratory study:

1. Formulating a problem for a more precise investigation;
2. Establishing priorities for further research;
3. Gathering information about the practical problems of carrying out research on particular conjectural statements; and
4. Increasing the analyst’s familiarity with the problem.

The main survey stage can thus be designed with these in mind rather than being based on the researcher’s pre-judgement, not researching the topic enough and collecting irrelevant data.

5.3.2 Descriptive research

This is a form of conclusive research which focuses on an accurate description of the variables under investigation (Hakim, 1989). Descriptive studies, in contrast to exploratory research, stem from substantial prior knowledge of the variables based on some previous understanding of the nature of the research problem. The purpose of descriptive research is also different from that of exploratory research. Effective descriptive research is marked by a clear statement of the decision problem, specific

research objectives and detailed information needed. In addition, it is characterised by a carefully planned and structured research design (Borg and Gall, 1983: 355). Among the purpose of descriptive research are:

1. To describe the characteristics of certain groups
2. To estimate the proportion of people in a specific population who behave in certain way
3. To make specific predictions.

5.3.3 Causal research

Causal research or experimental design is a form of conclusive research which identifies the cause and effect relationships among variables (Borg and Gall, 1983) pg. 355). In causal research the investigator usually tries to control all the variables so that by varying one while holding the others constant, he or she can identify the effect of the input or independent variable upon the output or dependent variable. Experimental research design can be subdivided into laboratory and field experiments. In the laboratory experiments the test is conducted in an artificial or laboratory setting in which the effect of all possible influential independent variables not pertinent to the immediate problems are kept to a minimum. On the other hand, a field experiment is conducted in the field. The respondents usually are not aware that an experiment is being conducted and so act more naturally (Borg and Gall, 1983; Hakim, 1989; Nachmias and Nachmias, 1996).

5.3.4 The chosen research design

Having identified the three types of research design, a blend of exploratory and descriptive research design was chosen for this study. The main reasons for this decision are:

- 1 The type of information desired;
- 2 The availability of resources;
- 3 The degree of control the researcher has over the selection and assignment of subjects; and
- 4 The ability to manipulate the independence variables.

Experimental designs do not seem appropriate for this study. This is because cause and effect relationships are notoriously difficult when controlling or manipulating the variables under investigation. Therefore, in this study a combination of exploratory case study and descriptive cross sectional method was used. An exploratory case study is needed in order to get a better understanding of the phenomenon unique to a Malaysian context and from the outcome the researcher is able to develop hypotheses for testing. In addition, descriptive cross sectional method was employed chiefly because this study has clear and specific objectives (Borg and Gall, 1983; Hakim, 1989; Nachmias and Nachmias, 1996). Discussion on the qualitative case study is discussed in detail in chapter 6

5.3.5 The methodological framework

In general, the methodological framework of this research is divided into five main stages. The first stage deals with the literature review which led to the setting up of the objectives. The Malaysian Educational Report is reviewed, together with the supporting study and reports (e.g. The Malaysian Plan Reports, the Reaccreditation by the Council for Architectural Education Malaysia (CAEM) Memorandum, the yearly academic report from the University of Technology Malaysia, the University Sains Malaysia and the Institute Technology of MARA) and other relevant documents (e.g. Ministry of Education handbooks and reports, and proceedings).

The second stage deals with the analysis of the current scenario and problems facing the architectural education as viewed critically from the general public and professionals on the performance of newly graduated architects. In addition, discussions with colleagues and lecturers in the architectural school from other higher education institutions in Malaysia, are conducted prior to the exploratory survey. This stage leads to the derivation of research problems and the issues which are used in the design of the interview schedule.

The third stage centers on exploratory interviews (i.e. focused group and personal interviews). The aim of the exploratory interviews is to obtain first-hand data on the issues and perceived causal problems regarding this matter. The results from the interviews and observations will be categorised into two sets of findings: the major issues which considered the most important and the minor issues which support the

major findings. Some of the latter issues are also treated as important but because of time constraints the issues will be suggested as ideas for further research. The findings from the exploratory interviews, with support from an extensive literature review, will be used as a basis to set the hypotheses and to provide the concepts underlying the development of the questionnaires. In this way, by using the statistical data analysis, more comprehensive findings can be derived. Details of the interviews: the design of interview schedule, procedure, sampling process, are discussed in the following (sections 5.5 and 5.6) respectively. However, analysis and findings from the interviews will be discussed in detail in chapter 6.

The fourth stage is the empirical analysis using quantitative methodology (questionnaires). The identification of major and potential issues and hypotheses testing was conducted. Quantitative methods are generally associated with systematic measurement, quasi-experimental and experimental methods, statistical analysis, and mathematical models (Linn and Erickson, 1990). The quantitative methods involved in this research are the use of questionnaires, and statistical data analysis. The advantage of conducting a questionnaire survey was that it allowed the researcher to acquire data from a large number of respondents (Nachmias and Nachmias, 1996). The measurement tool i.e. the statistical procedures applied to the research is the crucial element in the use of quantitative methods in this research. Details of the research instrument, sampling process and procedures, are explained in (Section 5.7). However, means of analysis pertaining to the quantitative methodology are discussed in Chapter 7.

The final stage is the presentation of the findings where conclusions and recommendations were drawn. The methodological framework of the research is illustrated in (Figure 5.2)

Research Methodology

A Qualitative/Quantitative Approach

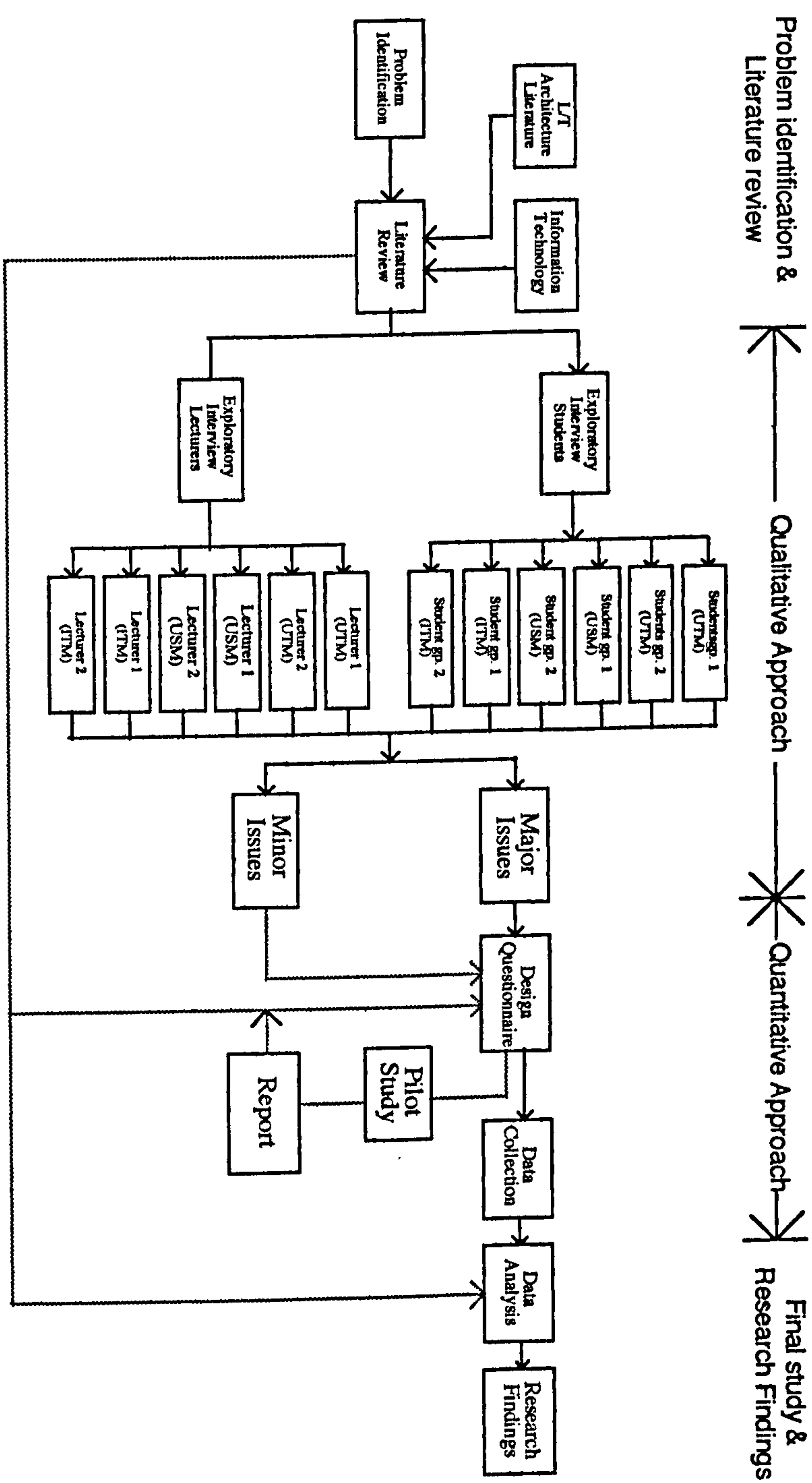


Figure 5.2 - The Methodology Framework (source: Author)

5.4 Survey research

5.4.1 Selection of universities

A survey can be defined as a specific method of collection providing deeper and more detailed information in specific areas of selected study and commonly covering a certain area of study (Borg and Gall, 1983). For the purpose of this research, three universities were chosen out of a total of nine universities in Malaysia (detail description and location of the universities is illustrated on figure 3.2, Chapter 3). Specifically they are:

1. The University Teknologi of Malaysia (UTM)
2. The University Science of Malaysia (USM)
3. MARA Institute of Technology (ITM)

However, the researcher decided to exclude University Malaya's architectural school because the school was only established in 1994 (Malaysia, 1996), thus, there was a limited numbers of respondents for the study. The researcher decided to select the above universities for the following reasons:

- a) The universities selected awards professional architectural degree (Lim, 1994);
- b) The architectural schools are well established and recognised by Pertubuhan Akitek Malaysia (PAM) and Lembaga Akitek Malaysia (LAM) (Lim, 1994); and
- c) The universities are well recognised and endorsed by the Malaysian government (Lim, 1994).

5.5 Sampling procedure

In practice, it is not feasible to interview all potential respondents unless the total population is quite small. Thus, it is fairly acceptable to apply a sampling method in fieldwork survey. Social science research conducted in various fields suggested several ways of taking samples. The main sampling techniques available to the researchers are probability and non-probability techniques. Probability sampling

results in every sampling unit in a finite population having a calculable and non-zero probability of being selected in the sample. Probability sampling is the only technique available that gives an objective measure of the precision of the sample estimated.

In non-probability sampling the probability of any particular member of the population being selected is unknown. According to Diamantopoulos and Schlegelmilch (1997) the selection of sampling units in non-probability sampling is quite arbitrary, as researchers rely heavily on personal judgement somewhere in the sample selection process rather than a mechanical procedure to select sample members. "There are no appropriate statistical techniques for measuring random sampling error from a non-probability sample. Thus projecting the data beyond the sample is statistically inappropriate" (Diamantopoulos and Schlegelmilch, 1997 : 13).

There are several forms of probability sampling and non-probability sampling. Diamantopoulos and Schlegelmilch (1997) summarised them as follows: (Table 5.2 and Table 5.3).

Table 5.2

**Forms of Probability Sampling and Non-probability Sampling:
Probability Samples**

Probability Samples	Sampling Procedure
(a) Random Sample	Every member of the universe has an equal chance of being selected.
(b) Systematic Sample	Every unit is identified, allocated a number and selected by a random process.
(c) Stratified Sample	The population is segmented into strata and random samples are drawn from each stratum by either method (a) or (b).
(d) Area Sampling	The population is divided into sub-areas, and the researcher draws a sample of the groups to interview.
(e) Cluster Sample	Requires the researcher to sub-divide a population into a set of mutually exclusive and exhaustive sub-groups.
(f) Multi Stage Sampling	The country is divided into a number of areas, and three or four areas are selected by random means.
(g) Multiplicity (Snowballing) Sampling	Sample member are initially chosen either judgmental or through a probability sampling methods and are subsequently asked to identify others with the desired characteristics; thus, the final sample is constructed from referrals provided by the initial respondent.

Table 5.3
Non-probability Samples

Non-probability Samples	Sampling procedure
(a) Convenience Sample	One solicits information from any convenient group
(b) Judgement Sample	The interviewer uses his or her judgement to select population members who are good prospects for accurate information.
(c) Quota Sample	The researcher interviews all the people he meets up to a given number, which is called his quota. Quota is nearly stratified to some extent: by age, social class etc.

5.5.1 Simple random sampling method

In this study, the sampling method employed is *Simple Random Sampling* (SRS) since it gives equal opportunity for every respondent in the three universities to be selected. First, to be more representative of students in second, third and fourth year of each university, a sample size of forty percent (40%) of the total students population in the respective year in each university was selected for the survey. The sample size at forty percent (40%) was chosen in order to ensure enough data was collected from the total population. In addition, Abu Bakar (1991) stated that most of the respondents in higher institutions in Malaysia have certain similar characteristics in common: age level, educational background, ethnic origins, etc. Thus, this study uses a sample size of about 40% of the total student population. It is assumed that the respondents have similar characteristics and that they fulfil the criteria of homogeneity. As Diamantopoulos and Schlegelmilch (1997) states that:

“A key statistical consideration in sample size determination is the degree of variability in the population; the more heterogeneous the population, the larger the size needed to capture the diversity in the population” (Diamantopoulos and Schlegelmilch 1997: 16)

For each university, a random number is selected according to the total number of students in the second, third and fourth years. For example, if the total number of second year students in Institut Teknologi MARA is 100, 40 numbers from

1 to 100 are selected randomly by picking out 40 pieces of paper from a box containing 100 pieces of paper numbered 1 to 100. The selected numbers then represent the respondent number. In other words, the sample corresponds to those selected random numbers. Those numbers which are selected cannot be reentered for further selection. In case the student selected is not available another number is picked as for replacement.

The advantage of this method is that every respondent has an equal opportunity to be selected. Furthermore, this method requires a good sampling frame (Diamantopoulos and Schlegelmilch, 1997) and since this is easily obtainable from the heads of schools of various universities, the process of determining respondents for the study is considered relatively easy.

5.5.2 Data Collection: Using drop-off and pick-up method

The best known source of primary data collection is the survey (Borg and Gall, 1983). Survey research includes "structured or semi-structured data collection methods, with the information being collected from a census of the population of interest or from a representative sample of that population" (Nachmias and Nachmias, 1996: 234). There are at least four techniques of data collection available which can be used to conduct the survey research, the main ones being:

1. personal interview,
2. telephone interview,
3. mail questionnaire, and
4. drop-off-pick-up method (ibid).

It was decided that personal delivery and collection or drop-off and pick-up method of a self-administered questionnaire would provide the most suitable form of data collection. This method has worked well in other educational studies (e.g., El-Oman 1991; Ghadir 1990; Kaynak et al. 1994; Lovelock et al. 1976; Niffenegger et al. 1980; Papadopoulos 1987; Shams 1996; Stover and Stone 1974).

Lovelock et al. (1976) recommended personal delivery and collection of self-administered questionnaires as being particularly appropriate for conducting detailed surveys of respondent's attitudes and behaviour patterns as was the case in this study.

The personal drop-off and pick-up method of data collection was found to be more appropriate for this study not only because it allowed respondents the opportunity to fill out questionnaires at a convenient time (Niffenegger et al 1980), but also because it gave high response rates as the respondents might have felt obliged to answer the questionnaire as promised (Papadopoulos 1987). In addition respondents were not subjected to interviewer bias because it was self-administered (Faria and Dickinson, 1996).

The only disadvantage of this procedure is it is tedious and it involves quite a large sum financially as the researcher had to fly back to Malaysia for a second time in order for her to carry out the data collection.

Due to the representative size, personal interview and telephone interview survey are inappropriate methods of data collection as the data needed was quite extensive and the design of the scales would have made it very difficult to execute this study using these techniques. A comprehensive assessment of the advantages and disadvantages of personal interview, telephone interview and mail survey are discussed in many educational research literature such as in Nachmias and Nachmias (1996: 239-244) and Churchill (1995a: 378).

5.5.3 Data collection activity

The research design developed for the current study identified the nature and scope of the data source required to answer the research questions. The sample for the empirical research is made up of students and lecturers of the selected universities in Malaysia. Each survey respondent shall agree to provide the information included on the questionnaire and administered in compliance with the research design. Each participant was assured anonymity in exchange for co-operation and for candid responses.

The data collection activity was conducted for three weeks in February 1997. This period was selected because it was the beginning of the semester and the staff and students were not very busy. Since the researcher is an academic staff of Institut Teknologi MARA (ITM), she was able to obtain permission to distribute and collect questionnaires from all the universities involved quite easily. The data collection went smoothly.

To ensure that the researcher collect information with maximum reliability and validity, the following measures were taken:

1. Great care was taken at all stages of the development of the questionnaire to ensure that the terms and words used would be easily understood by the layman. However, only the English version was distributed to the respondents taking into consideration that the respondents were well versed in the language.
2. Prior arrangement with the heads of schools from various participating universities was conducted in order to ensure the efficiency of the data collection exercise. This was felt necessary for questionnaire distribution and collection during studio hours. Thus, the researcher was able to get full response from the targeted respondents. It also reduced the risk of "non response" or "lost of questionnaire" as in the case of postal questionnaires (Borg and Gall, 1983; Moser and Kalton, 1985; Nachmias and Nachmias, 1996).
3. The construction of the questionnaires for both students and lecturers was a tedious task. Before the final form of the questionnaire was determined, many revisions in wordings, length and content were made as a result of getting people to complete the questionnaire. This group of people were the Malaysian students who are currently pursuing their first degree architectural study and the architectural lecturers of Malaysian higher education institutions who are also currently pursuing their doctorate degree in Sheffield University. The purpose was to ask them to check the questions with a view of ensuring that they were readily understandable and to identify possible ambiguities relevant to the higher education environment of Malaysia.

Once the final questionnaires was finalised, a covering letter was prepared for the purpose of explaining to the respondents the purpose of the research

5.6 The design of questionnaires

This section covers the design of the quantitative approach - the questionnaires. One of the prerequisites in designing a good questionnaire is deciding what is to be measured (Nachmias and Nachmias, 1996). There are basically three main approaches to developing initial indicators in questionnaire design (ibid.). These are:

- (1) using measures developed in previous research;
- (2) using observation or unstructured interview; and
- (3) using informants from the group to be surveyed.

Questionnaire items for this research were initially developed based on measures developed in previous researches made by researchers including (Pask, 1976,1985; Ford, 1980, 1985, 1995; Entwistle and Ramsden, 1983; Entwistle, 1988; Gagne, Briggs et al., 1992; Ford and Ford, 1994; Soo, 1995; Spitzer, 1996). However, the final version of the questionnaire items were modified based on information gathered from the qualitative case study undertaken by the researcher prior to the final survey.

The main aims of the questionnaires was to quantify the issues raised (the difficulties faced by students in learning the subject) and to investigate the nature of learning construction technology (pertaining to design practice). At the initial stage of preparing the questions, some major factors were considered. This involved the definition of the population in which the information was sought, the educational level of the students, length of questionnaire and researcher control over the responses. It was decided that in the interest of simplicity and consistency, questions should be standard and structured. It is important to note that in most of the questions the same words uttered by the interviewees during the interviews.were used The appearance, layout and length of the questionnaires were also considered.

There are two sets of questionnaires for two different target respondents. The first set of questionnaires is for the students and the second set is for the lecturers. The process of designing the questionnaires is discussed below:

5.6.1 Criteria used in student's questionnaire

It was identified from the interviews that at least four major issues were raised and discussed that affected the learning of construction technology in the Malaysian architectural schools. The questions in this section were aimed to investigate these issues further. The issues are:

Section A: Construction knowledge of students;

Section B: Learning methods adopted by students;

Section C: Aspects on learning that contribute to bridging construction technology with design; and

Section D: Prior knowledge or experiences of students (includes educational and biographical information).

The following explains each of the sections and summarises the intention of the questions in the table accordingly.

5.6.1.1 Section A: Construction knowledge of students

This section of the questionnaires involved questions which intended to identify students who were knowledgeable (referring to students who feel and think that they understand the subject) and those who were less knowledgeable (referring to students who feel and think that they are facing difficulties in understanding the subject). Since understanding and knowledge implies performance and it is non visual, it was found difficult or almost impossible to measure understanding or knowledge of an individual objectively (in most cases testing or preset experiment methodology were used). However, according to Burnham (1988) and Rambow, (1995) the students' honest opinions regarding their overall understanding and knowledge on the subject, can be used as a gauge to measure their understanding towards the acquired knowledge. What is of interest in a research according to them is the correlation between the answers. Hence, understanding and knowledge as variables can be gauged and used in the upcoming analysis. Additionally, the criteria of the questions were derived from analysis and findings from the interviews previously carried out.

5.6.1.2 Section B: Learning methods adopted by students

As we have discovered earlier in the interview, the key issues to the problem is the learning methods adopted by students. Students seem to be uneasy and discontented with some learning methods in order to pass examinations. The need to identify clearly and comprehensively on effective learning methods is vital to this research.

Based upon an enormous body of research on learning earlier, we can conclude that learners' ability to process and acquire different types of information is mediated by a diverse variety of individual cognitive styles of learning. The logical implication is that by accommodating to the **individual learning methods and prior experiences**, we will be able to nurture their intellectual potentials and capabilities. For example, in their study, Candy and Edmonds (1997) associate the criteria of behaviour into the issues on user action needs¹⁷ for the criteria-based modelling approach to interactive system design.

Another important criteria in learning method is **motivation** (Biehler and Snowman, 1993). Motivation plays a major role in learning. Students who are facing difficulties in understanding a subject will be a passive learner (Rogers, 1951; Rogers, 1969; Knowles, 1970; Rogers, 1986) and they will conform to certain learning activity that will just ensure their security in the class. Examples of such behaviour are lack of innovation, afraid of making mistakes and preference to mediocrity. This section intends to elicit problems regarding learning and understanding of construction technology specifically in relation to its application to design which thus revealing students' motivation. The respondents were asked on their general perception about construction in designing, for example, students were asked to indicate the degree of agreement or disagreement according to the Likert-scale (described in detail on Section (5.7.3) on some of the examples of the statements commonly uttered by them (statements quoted from previous interview):

"I prefer to create a simple form so that I won't face complicated construction problems"

"I will discard a possibly flamboyant design if I can't solve the construction problem", etc.

¹⁷ For further reading on how this model is developed, please refer to Candy and Edmonds (1997)

To sum up, this section involved questions which intended to describe learning methods adopted by students which include studying method, objective of learning, designing behaviour, motivation and time management, learning behaviour and practices.

What we can hypothesise from the above discussion is that the learning method adopted by the students affect individual understanding on a subject greatly which in turn will be reflected in their performance. If understanding is excellent, students usually perform well and it consequently relates positively in their performance in class as well as during subsequent employment. By the same token, if they do not perform well, it means that they have problems in understanding. What the researcher wants to discover here is whether performance affect the students' management. The researcher is aware that the findings on this matter would not be contributing much to the objective of the research but it could contribute to future research. With curiosity as an ally, the researcher is hopes to find out why architectural students lack skills in time management (Anthony, 1991).

5.6.1.3 Section C:

Aspects on learning that contribute to bridging construction technology with design

This section of the questionnaire involved questions which intends to identify aspects on learning construction technology that contribute to bridging construction theory learning and its application in design. Many authors like Dean and Whitlock (1983); Gagne, Briggs et al., (1992); Ellington, Percival et al., (1993); Falk and Carlson, (1995) revealed that one of the important processes in developing instructional program or activities is defining the objectives of the program. Since the research is geared to investigate the learning objectives of construction technology, the questions were based from the learning objectives of current syllabi and the overall goals of the curriculum.

5.6.1.4 Section D: Educational and biographical information

Finally, Section D seeks and examines educational and biographical data of each respondent. This includes names of institutions, years of study, gender and educational background. The intention of finding out their educational background was to identify the experience of the students in the architecturally related field.

The design intention and the final set of questionnaires for the students are produced in **Appendix 1** and **Appendix 2**.

5.6.2 Criteria used in lecturer's questionnaire

The findings from the exploratory interview (discussed in detail in Chapter 6) revealed that the majority of teachers of architectural design still follow some of the methodological or systematic approaches borrowed from the field of the physical sciences. The analysis-synthesis models and the linear process of problem solving still form the basis of many teaching strategies. On the other hand, there are few voices declaring these teaching ideologies to be no longer valid and new approaches on studio design have lead one to believe that teaching is heading towards the new direction. Nevertheless, the purpose of the questionnaire is not to debate on this issue but to see the profound effect of these teaching methods towards architectural learning process.

To achieve the above purpose, it is felt necessary to carry out further investigation on the issues raised by the students regarding their problems and difficulties in trying to understand construction technology. The objectives of the questionnaires were first, to identify these issues from the lecturer's perspective and secondly, to find the connection between the teaching method used and the learning method preferred in the learning/teaching of construction technology. The aim of the analysis is to investigate the matched/mismatched situation between learning and teaching in architectural education specifically in the learning of construction technology. The questionnaire consisted of four sections.

Section A: Teaching approaches;

Section B: Teaching concept;

Section C: Problems and difficulties of learning; and

Section D: Students background vs performance .

The design intention and the final set of the questionnaires for the lecturers are produced in **Appendix 3** and **Appendix 4**.

5.6.3 Questionnaire procedure

The questionnaires employed 48 statements for students and 30 statements for lecturers. In each case the respondents were asked to indicate the extent of their agreement/disagreement with a series of statements on a 7-point Likert scale¹⁸ where the anchor points of the scale were 'totally disagree' to 'totally agree'. The response scale was:

1 = totally disagree

2 = strongly disagree

3 = slightly disagree

4 = neutral

5 = slightly agree

6 = strongly agree and

7 = totally agree.

The type of questions used in the questionnaires are "close ended" questions whereby the respondents were offered a set of answers (Likert scale) and were asked to choose the one that most closely represents their views. The seven point Likert-type scale was chosen as an evaluating means because the researcher is interested in measuring the views and attitudes of the respondents. It will then be used to justify the stated hypothesis. With this scale, the respondents will have a wider range of answers to reflect their views as compared to the five point Lickert scale (Nachmias and Nachmias, 1996). The researcher can ascertain with great accuracy both the

¹⁸ Please refer to Nachmias and Nachmias (1996: 465) on compiling possible scale items on Likert scale measure of attitudes

strength of the respondents' views and attitudes and the conditions under which his views and attitudes may change. In general, the researcher conformed to a standard format of questions (except for the educational/biographical background) because of two reasons:

- i) To maintain the simplicity and consistent format of the questions and answers so that it will be less tedious for the respondents to read and answer the questions; and
- ii) To maintain the standard format throughout the questions so that it will be much easier and systematic for the researcher to analyse the data.

5.6.3.1 Students response

The questionnaire sessions were to be carried out during studio hours, the researcher expected to have a full response from the target population (i.e. second year to the final year diploma students of the three architectural schools previously mentioned). However, there were a few absentees, and these were not included in the survey. The total number of respondents from the student section were (N=447) from a total population of (n=1118) making a total percentage of 40% responded to the questionnaires. A larger random sample was attained as the larger sample is less likely to give a negative results or failed to reject the null hypothesis and to ensure to some extent the uncontrolled variables will themselves be operating randomly (Borg and Gall, 1983). A detailed description is shown in Table 5.4.

Table 5.4: Respondent Sample Statistics (Student Session)

Name of Institution	No of respondents	population (Arch. dept. - 1996)	Percentage(%)
1. UTM	142	355	40%
2. USM	118	295	40%
3. ITM	187	468	40%
Total no of respondent (N) = 447		Total population (n) = 1,118	40%

5.6.3.2 Lecturers response

Teachers were selected from those who were involved in the teaching of construction technology and design. The problem for this group sampling is to get a large population as only a few lecturers were involved with the teaching of construction technology and design. The sampling size is important to determine the significant value and the validity of the data (Nachmias and Nachmias, 1996: 194). The researcher managed to get 32 teachers (N=32) from a population of 94 (n=94). Making the response at 34%. The small sample size could have an effect on reliability. However, a high level of consistency was found in the answers to most of the questions. (Details are shown in Table 5.5 below):

Table 5.5: Respondent Sample Statistics (Lecturer Session)

Name of Institution	No of respondent	population (Architecture dept. 1996)	Percentage (%)
1. UTM	10	29 (14 active 15 inactive)	34.5%
2. USM	09	25 (14 active 11 inactive)	36.0%
3. ITM	13	40 (28 active 12 inactive)	32.0%
Total no of respondent (N) = 32		Total population(n) = 94	34.0%

5.7 Data analysis techniques.

The field work achieved its initial aims, that is, to conduct the interviews and questionnaire surveys. In addition, it provided an invaluable opportunity to meet academic staff and students of other universities and to utilise their libraries. The procedures used for analysing the exploratory interviews and findings will be discussed and presented in detail in chapter 6. On the whole the interviews provided the opportunity to gain valuable information relevant to this research.

The quantitative data gathered from the questionnaires were analysed with the help of a computerised statistical package, namely the SPSS (Statistical Package for Social Sciences). The procedures used both descriptive and inferential statistics.

Descriptive statistics as involve methods that describe data for making decisions. It enables the researcher to summarise and organise data in an effective and meaningful way. The procedure provides tools for describing collections of statistical observations and for reducing information to an understandable form (Nachmias and Nachmias, 1996: 355). This study, used descriptive procedure to provide summary statistics that are useful in describing the distribution of the respondents under investigation. The researcher mostly employed the frequency distribution and mean score to display a useful '*picture*' of the observations. This is a preliminary step towards data interpretation and assumptions on the hypotheses.

On the other hand, *Inferential statistics* allow the researcher to make decisions or inferences by interpreting data patterns and to determine whether an expected pattern designated by the theory and hypothesis is actually found in the observations (ibid: 355).

In determining the statistical tests which apply to the data analysis, consultations were made with staff members of the Statistical Department and Architectural Departments of the University of Sheffield. On their advice, it was decided that descriptive analysis, T-test (Independent-Samples T-test. and paired T-test) and Pearson correlation coefficient factor analysis be used for this study.

5.7.1 Descriptive analysis

This is a preliminary data analysis that helps summarise the general nature of variables included in a study.

“...descriptive analysis provides a very useful initial examination of the data even when the ultimate concern of the investigator is inferential in nature.” (Diamantopoulos and Schlegelmilch, 1997: 73).

It has been noted that the initial task of any analysis is to determine the basic distribution characteristics of the variables. In the current study, these characteristics were determined principally through frequencies and percentages. In addition, a comparison of means for scaled (e.g. from totally agree - to totally disagree) questions in order of importance were also considered. The higher the mean, the more important the factor was considered by respondents.

5.7.2 Comparative analysis using differences in mean scores

The procedure is used to prove that two means of independent samples are not equal. The analysis is explored by the results of what is termed as Independent-Samples T-test. The procedure is used to test that two means of independent samples (for interval data)¹⁹ are not equal. In this case, the independent samples are two groups of students. The first group are those who gives a higher rating on question 1 which is *"I rate my overall understanding on construction technology as high"* (please refer to Q1 on questionnaires for students) and the second group are those who gives a lower rating. To make the analysis easier we called the first group the *"understand"* group and the second one as the *"don't understand"* group. This analysis is used to investigate the mean differences in their learning methods between the *"understand"* group and the *"don't understand"* group.

A two-tailed test at 95% Confident Interval is used to detect the differences in means between these two groups. The rule is that, if the 2-T significant is small enough and/or less than 0.05, the null hypothesis (*H₀*) that the group means are equal is rejected (Norusis, 1995). Hence, using this procedure, one will be able to calculate the mean difference and the significance of the test will be determined. This analysis also serves as a justification to select the variables for the correlation analysis.

This method of analysis was chosen due to the following reasons:

1. The large number of respondents
2. The distribution is considered normal
3. The difficulties of using the chi-sq analysis of significance since we cannot use this test when more than 20% of the expected frequencies are smaller than 5 or at least one cell has expected frequency of less than 1 (Diamantopoulos and Schlegelmilch, 1997:156).

¹⁹ See (Diamantopoulos and Schlegelmilch, 1997: 174) for a discussion on the selection of appropriate techniques for making comparison.

5.7.3 Measures of association - using Pearson's Product Moment Correlation (r).

Relationship (or association) plays an important role in data analysis (Diamantopoulos and Schlegelmilch, 1997). In this case we would like to investigate whether two variables (bi-variate) are related and if so, what is the nature, strength and significant relationship between them. According to Diamantopoulos and Schlegelmilch (1997), studying the nature of relationship is important as not only one can find out if a relationship exists between two variables but also in the way in which the two variables are related to one another: a positive or negative correlation (Norusis, 1995; Diamantopoulos and Schlegelmilch, 1997).

Another aspect of a relationship is its magnitude or strength of the relationship. This measurement tells us how closely two variables are to one another. The measures of association are usually calibrated between the range of 0 and ± 1 (i.e. complete dependence) and 1 a perfect relationship (the [+] and [-] sign indicating the direction of the relationship). A rule-of-thumb of measurement considered the correlation is "strong" when the association measure is larger than 0.8; "moderate" when the association measure lies between 0.4 and 0.8 region and "weak" if the association measure below 0.4²⁰ (Norusis, 1995; Diamantopoulos and Schlegelmilch, 1997).

There are various measures of bi-variate association depending on the nature of the variables tested. For this case, the test was for examining the relationship between interval variables. Hence, the method of testing the relationship will be the Pearson's product moment correlation or in short the *Pearson's correlation* denoted by the sign (r). The hypothesis was tested by one-tailed at the 95% confidence interval (Norusis, 1995; Diamantopoulos and Schlegelmilch, 1997).

²⁰ Note that with real-life data, it is very unlikely that a measure of association will reach its extreme values (i.e. 0 or 1). Thus, when dealing with sample data, it is important to test whether a value produced by a measure of association does in fact reflect the existence of a 'true' relationship in the population (Diamantopolous 1997)

5.7.4 Transformation of data

Prior to hypothesis testing, one very important step, is to check the questionnaires. Since the questionnaires are set in seven point Lickert-scale measurement, the tabulation of the responses would be massive and untidy (i.e. larger table). For example, if we tabulate Q1 with Q7 and each of the question consists of seven point Lickert-scale responses, the tabulation would consists of 49 (i.e. 7 x 7) responses. As a result, the analysis loses strength. Furthermore, too many cross-tabulation will result in too many expected values in a table being less than 5 and also the observed significant level based on chi-square distribution may not be valid (Norusis, 1995)²¹. To overcome these problems, the researcher simplified the responses into categories. This method of transforming and recoding a set of data into simplified categories and assigning it to new values is called *transformation of data* (Norusis, 1995)²². In this context, the researcher assigned a new value from the seven point Lickert-scale responses into three scale or categories responses and redefined the values into new names associated with the appropriate factors to be analysed. The recoded value and names of the variables were outlined as below:

Dependent variables (Question 1)

(Rating by students on understand/don't understand construction technology from question 1):

<u>Seven point Lickert-scale</u>	<u>New recode value</u>
7 - 5	Understand
4	Neutral
3 - 1	Don't Understand

Educational background is a qualification used by students to enroll in higher institutions. Practical training and work experience are classified in this research as the *prior knowledge*²³ of the students. Students entering university using SPM, STPM and Matriculation are referred as students with no experience (NoExpe) and for those entering university with some technical training or working experience they

²¹ A general rule is not to use chi-square test if more than 20% of the cells have expected values less than 5, or if the minimum expected frequency is less than 1 (Norusis, 1995: 334)

²² According to Norusis (1995), there are various means of transforming data. One can do through computing calculation data values according to precise expression, by automatic recording or by assigning the new values replacing the old ones (numerically or assigning string values).

²³ In this investigation, practical experiences in architecture field specifically in building and construction works are considered as the prior experience.

are referred in this study as students with some experience(Expe)²⁴. The categorising is shown below:

Independent variables (Question d)

Educational background

SPM, STPM, Matriculation

SPM+V, SPM+P, SPM+W

New recode value

NoExpe (student with no experience)

Expe (student with some experience)

note:

SPM, STPM, Matriculation = Acronyms of students' qualifications

SPM+V = Students trained in vocational schools

SPM+P = Students trained in polytechnics

SPM+W= Students with working experience (construction)

5.8 Limitations to research methodology

The anticipated constraints to the research methods are based on combining qualitative and quantitative methodologies for this research. The first and greatest limitation to this research was financial. Combining quantitative and qualitative methods were very expensive. The expenses included preparing hundreds of copies of the questionnaire and interview schedule and stationery costs. Although partly subsidised by the department, the cost for telephone bills, transportation and accommodation occurred during the field work was large.

The second problem was that using both methods took a great deal of time. This included planning for the prospective interviewees, selecting the respondents, and distributing the questionnaires. Apart from having difficulties in getting the respondents (lecturers) to agree to use his time for the interview to be carried out with the students, there were difficulties in getting appointments, and a long waiting time before the interviews took place. Sometimes interviewees, in the case of lecturers, were difficult to locate or were busy. As a result, interview appointments had to be rearranged several times. In other cases, interruptions during interview sessions (e.g. telephone calls) delayed the interviewing process.

²⁴ Please refer to entry qualification for university enrolment in the school of architecture, Malaysia, page 54-55

Generally, the main aims of conducting the field work were achieved within a short period. However, having more time would have provided opportunity to conduct interviews, meetings and questionnaires with the private schools of architecture in the country. The limited period allocated for the field work was not only subjected to the limited amount of funds allocated and it also had to fit into the 3-year study plan for accomplishing this research.

Last but not least, the unavailability of references on the subject hampered the study. Although there was a large body of literature on architectural learning and design, much less has been written on aspects of learning construction technology, particularly on the issue of technical learning versus designing process. Since this research is based on a Malaysian setting, any related research previously done on aspects of learning and architectural learning in higher institutions of Malaysia would have been most helpful, but none was discovered. There is a definite weakness in supporting literature as well as a lack of a valid comparison. The only supporting literature was on general issues, such as the general aspects of learning within the cultural boundaries.

Nevertheless, the limitations and problems that came up while conducting this research have not prevented the researcher from investigating the key issues involved and in Malaysian setting, the researcher is happy that it serves as a groundbreaking study to be, hopefully, further advanced by other researchers.

5.9 Summary

In this chapter we have examined some of the major issues involved in selecting a research design, a questionnaire design, sampling procedures and collection of data through various methods. The uses and advantages as well as disadvantages of the various approaches were looked at in some detail. Data analysis statistics and the limitations of the methodology used in this research were also examined. Details of the qualitative and quantitative data analysis will be presented in chapters 6 and 7.

Chapter 6

Qualitative Findings: Interviews with Students and Lecturers

6.0 Introduction

In Chapters 3 and 4, attempts were made to explain the development of different learning theories and how different learning environments emerged on the basis of these theories. We also discussed the various learning styles that are associated with the students of the arts including architectural students (Lawson, 1975, 1979, 1990, 1993, 1994; Tovey, 1984; Cross, 1985; Lawson and Roberts, 1991; Candy and Edmonds, 1997).

This chapter describes an attempts by way of exploratory research towards the typology of the learning methods (internal learning factors) and the teaching methods (external learning factors) affecting the performance of the architectural students. More importantly, the chapter presents the results of the interviews (students and lecturers) which are used primarily in the designing and constructing of the second stage of the data collection - the questionnaires. The issues discussed in this chapter are divided into the following sections:

- Section 1:** Aim of the interviews;
- Section 2:** Questions put to the students;
- Section 3:** Questions put to the lecturers;
- Section 4:** Findings from the interviews.

6.1 Aim of the interviews

The method used during the exploratory survey was the non-directive focus group interview with students and personal interview sessions with lecturers from the three architectural schools in Malaysia (methodology, selection of the universities and sampling were discussed in chapter 5). The aim of this method of research is two-fold: first the interview was designed to enable hypotheses to be gathered relating to the different kinds of problems, difficulties, approaches, attitudes, perceptions, motivation etc. towards the learning of construction technology which exists in the sample under review. In this respect it is used as the first stage of a two-stage inquiry whereby the second stage attempts to quantify the attitudes on the representative sample (using Likert scale method). Second, the interview is aimed at providing in-depth explanations of the underlying problems - explanations which can only be inferred indirectly from behavioral data and which are only derived inadequately from 'why' type questions in standard questionnaires.

6.2 Questions directed to students

The questions posed to students were designed to find out their learning methods, designing methods and problems. In the learning construction technology specifically in relation to the design process. They were also aimed at getting feedback from students to some of the lecturers' remarks described in section 6.4.3 (about students' learning attitudes and motivation). The questions were divided into four parts.

The first part asked some general questions about prior knowledge and if this has any bearing towards better understanding in learning construction technology. It is also felt necessary to ask these questions as an introduction to the interview session and to make the participant adjust to the interviewer. This was followed by questions on their learning methods and problems in the learning and understanding of construction technology specifically in relation to the design process. The questions used for the first part of the interview schedule were:

- Briefly describe your educational background? When did you join the university? What was your qualification when entering the university?
- How do you find the course?

- Do you think your experience helps you understand construction technology?
- Do you find construction technology interesting? Why?
- Do you have any difficulties in understanding construction technology especially when applying it to design process? If you have difficulties, can you elaborate on them?

It is assumed that the students are subjected to various kind of learning styles, methods of studying (please refer to chapter 4) and teaching methods (please refer to chapter 3). For example, taking notes during lectures, rehearse information, generate visual images of facts they want to remember, etc. The second part of the interview was constructed to reveal the learning methods adopted by the students, their learning motivation and the teaching methods preferred, in relation to construction technology learning. The questions used were,

- What are your study methods in construction technology?
- How do you normally study construction technology?
- Do you understand the lectures in construction delivered in the class room? Please elaborate.
- Do you approach your lecturer if you do not understand the lecture given? What specific area do you ask him?
- Do you do any discussion on the subject with anyone? How often and with whom do you discuss?
- Do you receive feedback (from the lecturers or other professional persons) regarding construction technology? Is the feedback encouraging or threatening?
- Which teaching method suits you in learning building construction?

The third part of the interview was constructed to unearth the problems faced by the students towards learning and understanding construction technology in relation to designing process. The purpose of investigating this relationship is to examine the causes and root problems faced by the students while designing, for example, why they tend to segregate knowledge learned from the lectures (theories on construction technology) when designing. In addition to this, from the researcher own observation as an architectural lecturer and from complaints received from other lecturers, it is found out that students tend to discard their flamboyant design due to incompetence to

solve technical problems (in this case the construction problems). This is fully supported from literature review on architectural learning (Meunier, 1980; McSheffrey, 1985; Peters, 1986; Gutman, 1987; Smith, 1987). This attitude will not only demotivate the students but it will affect the overall design performance. The questions posed to them were:

- When you are designing a building, what factors do you consider to be most important? Why?
- What steps do you take to solve your design problem? Do you encounter difficulties doing your design project. Please elaborate.
- Do you have problems applying construction knowledge in design? If yes, can you explain the problem? What do you suggest to solve or improve them?
- How important is construction knowledge in design?
- Do you think construction knowledge is important in generating creative ideas in design?

Finally, we also probed for the overall competency of the students in designing. Below are a few examples of questions posed to them. The aim is not to pin-point students' knowledge on the technical aspects of construction, but to gauge their competency on the subject which indirectly reveals their understanding of the subject. This is then followed by a direct question in their competency in the subject construction technology. Examples of the questions are:

- If you were given a task to design and build (e.g. a single or double story house), would you be able to do so?

OR

- Can you explain in your own words, how to build a timber pavilion?
- How would you describe your competency in construction technology?

6.3 Questions directed to lecturers

The first part of the interview with the lecturers was constructed to reveal their general experience concerning individual approaches to architectural design. They were asked on two closely related activities which is designing and teaching design. - Designing is primarily concerned with the creation of a building which includes its expression of form, space and function while teaching design is concerned with the

procedures and principles to nourish and develop the students' design skill.(Billings and Akkach, 1992) . These ideologies will determine the kind of knowledge lecturers impart to students through lecturing construction technology and design studio. The questions used were:

- How long have you been working in the university?
- Do you have any working experience before joining the university? Where?
- Do you think your working experience helps you in your teaching? In what way(s)?
- We believe that each individual has his own set of principles (ideology) of teaching design, can you please list them according to priority. Do you follow this ideology when teaching?

The lecturers were cautiously investigated on their formal teaching methods, media used by them during lecturing, their views on learning and their commitment towards students.

- Please describe your specific method(s) of teaching construction technology? Please describe from the introduction of the program to the evaluation of the students?
- Do you find this method of teaching adequate?
- What are the difficulties and problems in carrying out this program?
- Please describe your specific method(s) of teaching/tutoring design in the studio? Please describe from the introduction of the design program to the evaluation of the student?
- Do you find this method of teaching adequate?
- What are the difficulties and problems in carrying out this program?
- What are other means of teaching construction technology do you suggest to improve teaching in your institution?

As there are differences in opinion on teaching and learning methods between the teaching group (lecturers) and the learning group (students), it is expected that the needs and wants of the students and the lecturers will be different. These examples of questions tried to focus on this issue:

- Do your students ask questions during lecture time? How often do they ask? What specific area do they normally ask? How do you react towards these questions?
- Do you see any problems faced by the students in understanding construction in relation to the design project? Can you identify the problems? What are your suggestions to help solve these problems?

The lecturers were asked to give their personal comments on the overall students' performance in their class. For example,

- Do you think students enjoy learning Construction Technology? Please elaborate.
- In your opinion, how committed are the students towards the subject?
- How would you describe the students' overall competence in this subject?

Once the interview schedule was set up, it was then piloted by interviewing two Malaysian students of the second and final year from the architectural school and two Malaysian architectural lecturers who are currently doing research program in the University of Sheffield. This was conducted in order to gauge whether the questions asked were easily comprehensible by the respondents. Furthermore, it gives the researcher a first hand experience to interviewing.

The interview schedule contains questions which are reproduced in **Appendix 5** and **Appendix 6**, served as general guidelines to the interviewer/researcher.

6.4 Findings from the interview

The assessment from students' and lecturers' responses were made in terms of their views on the learning situation and difficulties they experienced. A full verbatim transcription was completed by the researcher in order to analyse the findings. Further, a computer program "NUDIST"(QSR, 1996) was used to help the researcher identify key issues from the interview sessions. (Detailed questions, answers, preliminary analysis and summary of the findings from the interviews with the students and with the lecturers are presented in **Appendix 7** and **Appendix 8** respectively).

To summarise, there were three major issues that persistently emerged during the group discussions: **First**, the differences in the preferred method of learning of the students and methods of teaching employed by the lecturers; **second**, the contribution of prior knowledge towards learning and understand; and **third**, learning methods of students. The issues are discussed below:

6.4.1 Preferred learning method

Three main problem areas came under constant discussion and were continuously referred to were in the scope of *learning method*, *learning preferences* and *motivation*. These problems were brought up by both students and lecturers. Students indicated that present methods of teaching are not positively contributing in understanding the subject. It was found from the interviews that effective learning on the part of the students can be improved by using the following methods:

6.4.1.1 Learning from site (learning through example)

Students seemed to be critical of the lecture method, the current method of teaching. They have difficulty learning through just one sense, the sense of hearing. It is found that most students favoured learning at the site than others. They believe they can understand better through looking at the actual construction process carried out at the site. Therefore, the advantage of seeing, hearing, and with further exposure to actual construction experience seems to make them appreciate and understand the subject much better. One among the other statement made by these students concerning the issue:

"When we go to the site we can learn construction technology from all aspects. We can learn its system, the jointing, detailing and materials used and most of all it offers us the experience which we cannot get from reading books"

In consonant to the above the lecturers indicated that site learning is very effective. However, this method has a few drawbacks. It is time consuming; it has a noisy learning environment; and the tedium of conforming to restrictive safety regulations render this method difficult to implement.

"Our government is trying to expose [foreign construction] technology to the country. We rely heavily on international expertise so we are losing a lot of money to foreign skilled workers, for example, the Batu Tiga Stadium: The architect was Malaysian, Hijjas Kasturi, the engineers were from Germany, and the contractors were from Hungary. The Kuala Lumpur Twin Towers (KLCC) which are the tallest buildings in the world, Kuala Lumpur International Airport (KLIA) and some others involved foreign industries, foreign contractors and foreign designers. For instance, the architect for KLCC was Cesar Pale and the contractors were from Japan and South Korea. For the Telekom Tower, the architect was Kumpulan Senireka [Malaysian] and the contractors were from South Korea. The KLIA was designed by Koshu Kirokawa, a Japanese....We can use the above experience by exposing our students to the construction site as case studies. This will expose students to the problems and techniques of construction, such as, in the Batu Tiga Stadium where the structure was erected without columns But of course, this is time consuming" (Arshad, 1996).

"The problems regarding site visit, are the hassles and difficulties faced in trying to explain to forty to fifty students at one time and controlling them through the site especially when you take first year students" (Kamisan, 1996).

"This is something which I failed to do ... go to the site. I must admit it is because of time. To me learning from the site is the best (with emphasis) way to teach. You go to the site, you actually see those things on site, touch it, feel it, and that is the best way to teach it" (Jaafar Mohamad, 1996).

6.4.1.2 Hands-on experience

Besides site learning students also like 'hands-on experience' learning. In this method students actually construct the building themselves. In the case of the architectural school, experiential learning can be achieved through two ways: first, through *doing a study model* and second, through *actually doing a full scale project* (Vestuti, 1993). This approach claimed to have motivated students to learn; elevate students' sensitivity towards materials, texture of the materials, relationship between the physical built form and the user; and enhance their capability to come up with immediate solutions of design problems in relation to construction. During the interview, students from University Technology Malaysia explained that their understanding in construction technology partly due to their experience in constructing

a small timber pavilion set up by the university as a term project. A student confidently said:

“I have no formal training or working experience in construction before but I feel the experience I had on constructing the “wakaf” (Bahasa Malaysia for pavilion) last year really made me understand construction especially timber construction.”

On the other hand, there were criticisms by many lecturers that only study model fabrication was considered appropriate as the aim of the university is not to train students to be experts in the technical aspects of carpentry or concrete building. For students, it is only essential for them to learn the conceptual aspects of construction. One of the lecturers commented:

“I don’t think it is necessary, because we are not going to be carpenters. That workshop is only for you to know timber joinery and bricklaying. We don’t have to have workshop for that. We can just have brick models. That is good enough or you just pick up bricks and show the works that’s all... What is more important to me on the understanding of construction is to stress on structure [and] how structure is related to construction. It has to go hand-in-hand, for example [if] you want to test a roof structure, the lab is better [for this] than the workshop. The structure testing lab will be more beneficial than the workshop where students can appreciate beam and support, understand the function of beam, and can see a roof structure or a king post and test it in the lab” (Hamidun, 1996).

6.4.1.3 Visualisation

Construction technology covers a wide range of topics from an understanding of how elements are arranged to complex structural calculations. The requirements needed to accomplish these range of topics require a thorough analysis on the media used in order for the topics to be effectively learned. For instance, building construction needs lots of visual display (Green, 1974; Cross, 1984; Gross, 1994; Brady, 1996). Clearly a single medium is incapable of providing all of these. It is more appropriate to consider the real need of the subject in order to develop the most appropriate resources necessary to enhance learning.

The majority of the students interviewed emphasised that they can understand the subject better with proper visual aids. Many of them commented on the present teaching methods as:

“very superficial...”

“lack of visuals..”

“blurry and lack in-depth information...”

“too much theory...”etc

One of the second year student from USM (University of Science Malaysia) commented that:

“I am not happy with the way we are taught here. I can't get the essence of learning construction [...] may be lack of visual contact as I learn faster (better) through visual, especially 3-D like videos or slides [...]. I prefer video better than slides as slides is stiff and still using two dimensional illustration. Good video can illustrate building materials and assembling of buildings clearly. I also wish we can see animation of these processes.”

Students' attitudes towards learning construction technology were considerably influenced by the need to visualize three dimensional illustrations (3-D illustration) such as *animation on the assembling of building components, axonometric drawings, exploded forms and videos on the problems and difficulties faced during the process of construction*. In fact perception towards three dimensional drawings were highly favoured by them and perceived as one of the best methods to better understand construction technology towards its application in design. The majority of the students interviewed pointed that they understand the subject much better with appropriate visual aids. Many of them are not satisfied with the present teaching methods.

6.4.2 Learning methods of students

The main method of learning construction adopted by students was rote learning. However, it was found that students also used repetitive sketching especially on detailing of various construction techniques so as to help them do construction drawings in examinations. This method of learning is partly due to the assessment procedure used by the university to evaluate student's progress where 60 percent to 70 percent of the assessment were based on their examination results (Universiti Sains Malaysia, 1994; Universiti Teknologi Malaysia, 1994; Institut Teknologi MARA, 1995). The key problem to this method of evaluation is that it results in surface learning. The subject matter is not understood in depth (Biehler and Snowman, 1993) .

Students need to learn construction technology through understanding not memorising. The need for real subject understanding outlines the objective of the research.

It is also important to look into some other means of learning and understanding construction technology as practiced by these students. Quite a number of times students mentioned that they normally seek advice or discuss with their friends or seniors on construction problems. They were more comfortable and understand better when discussing with their peers.

6.4.3 Attitude and motivation

Despite numerous discussions on students' learning problems, there was hardly any mention of their antipathy towards construction technology. All students agreed that they are motivated to learn the subject but are faced with problems understanding it.

Probably the most significant issue to this problem is the underlying learning motivation towards this subject. Students are motivated to learn to achieve goals that they consider relevant to their needs. This to some extent justifies *Maslow's Hierarchy of Needs*, where a learning goal is an instructional purpose, aim or objective that is set before students as a mean of encouraging learning (Maslow, 1987).

These learning goals by themselves serve to motivate students to achieve a certain level of competency in a particular area. Such goals can be a short term (when lecturers ask students to complete a short assignment or just to pass the examination) or long term (as when we ask them to study in order to understand its usage in design that may be used repeatedly over a long period of time). The effective lecturer will be able to set meaningful and relevant goals that encourage learning.

From the interview, it is gathered that the general attitude and motivation of students towards learning construction technology are amenable to motivation that involves long term goals.

Three other factors that motivate student in the process of learning were found, namely:

1. Lecturer's enthusiasm for the subject (dedicated lecturer);
2. Positive relationship between lecturer and student; and
3. Well organised system of communication and instruction.

Additionally, students criticised the assessment on design project which according to them, heavily emphasised the presentation aspect. To accommodate this, less effort is put into construction technology or any other technical subjects in design. In the statement below, one student expressed regret towards remarks made by one, of his lecturers.

"In my opinion, the school emphasise too much on presentation (colour, drawings, etc.). Matters relating to construction and materials is not of importance to us anymore. Once my tutor even said, No color, Fail!"

Because of this students drift away and lose a lot of time trying to fulfill this requirement and with this neglecting the importance of construction technology in their design.

6.4.4 Other issues

6.4.4.1 Educational background

It was gathered from the interview sessions that students with some technical experience were able to reflect and relate impressively with matters concerning construction. These students are very independent and know exactly what they are supposed to do during the course. They take their own initiative to look at construction sites and do their own analysis of the construction work.

Conversely, students who enter the university direct directly from secondary education (referred in this thesis as *fresh students*) face some difficulties in understanding the subject. They felt that their previous knowledge from school have little or no bearing at all towards understanding of construction technology.

"My previous knowledge from school do not contribute much towards my present study because the subject is totally different and there is no relationship with the course I am in now".

“Since I have worked as a draftsman before I have no problems in understanding construction but I now face problems in design. To me I consider the knowledge in construction learnt before contribute a small portion in my understanding of architecture. I believe I still lack knowledge of modern or new technology”.

6.4.4.2 Time management

One aspect of architectural education is design studio. The creative process demand much attention and dedication (Anthony, 1991). Students claimed that they are bogged down with design projects and are also loaded with other ‘irrelevant subjects’²⁵ which affect their time management. Due to this they work long nights which affect their performance in design.

6.4.4.3 Learning culture

It is vital to mention here about one important aspect of learning which might be taken for granted by students and lecturers that is, the gap existing between students and lecturer is considered by the researcher as quite big. The respect and the responsibility of the lecturers are sometimes misunderstood by the students as the authority power over them. In this situation it is quite frustrating to find out that students prefer to be *passive learners* especially in matters concerning their thought against certain issues or disagreement in regard to subject matters. This same issues has been mentioned in other research concerning issues on learning and culture (Mohamad Abu Bakar, 1996; Nik Mustapha Nik Hassan, 1996). The problems could never be solved over night. It needs to be looked upon carefully and not within the researcher scope to attempt resolving it.

²⁵ Irrelevant subjects in this context is referred by the students as other prerequisite requirement by the university including some general subjects like chemistry, mathematics, English, religious study and extra curricular activities.

6.5 Summary

There exists a wide range of problems connected to learning construction technology in relation to design. Students rely heavily on the solution to this problems while, lecturers need to know how to solve the problems as to upgrade the performance of their students. The findings from the interviews show that the two groups are equally involved in this situation; from the learning aspect and the teaching aspect.

We examined the major issues, and the minor issues involved in learning and teaching construction technology. The results of the analysis from the interviews are used in the designing and constructing of the second stage of the data collection - the questionnaires. Details of the questionnaires, data analysis and findings (from the questionnaires) are presented in chapter 7.

Chapter 7

Questionnaire Results, Analysis and Discussion

7.0 Introduction

The quantitative methods used in this research are questionnaires and statistical data analysis. The questions in the questionnaires were mainly derived from the interviews. The aim of the questionnaires was to quantify the issues raised in attempting to understand learning construction technology in architectural education through hypothesis testing. It is important to note that many of the questions utilised the same words used by the interviewees during the interviews.

This chapter presents the results of several tests which were performed on students and lecturers from the architectural schools in Malaysia in order to understand their relation to the hypotheses outlined earlier. Each hypothesis is presented and then followed by the appropriate confirmation procedures with an ensuring discussion from previous research. The issues under investigation in this chapter are divided into the following sections:

Section 1: Description of the variables.

Section 2: Analysis on learning characteristics factors

Section 3: Analysis on prior learning experience

Section 4: Analysis on methods of teaching construction technology

Section 5: An analysis of the relationship between understanding construction technology and students' performance in the designing process.

Section 1: Description of the variables

7.1 Description of the study's variables:

The purpose of this section is to provide a brief discription analysis on the response patterns for sets of variables that had received comprehensive investigation in the study. It provides the frequencies and percentages of the responses to each variable and a brief description of the variables' general behaviour.

7.1.1 The demographic variables of the sample

Sample characteristics which appear in Table 7.1 shows the percentages of the respondents in accordance with different classifications of background i.e. university (the university where the student studies), year of study, gender and entry qualifications. The percentage distribution of the students by classification of university are as follows; 31.8% of students from the University Technology Malaysia (UTM), 26.4% of students from the University Science of Malaysia (USM) and 41.8% of students from the Institute Technology MARA (ITM). Meanwhile, the distribution of students by year of study consists of 42.7% from the second year, 34.0% from the third year and 23.3% from the fourth year. Nearly two thirds of the students in the sample (64.9%) were male and only one third (35.1%) were female. Of the total, only 11.4% had previous architectural experience while 88.6% had no architectural experience - as matter of ease to readers, they are referred as *fresh students* from high schools. Below are the summaries of the demographic variables of the students.

Table 7.1: Summary of the demographic variables of sample (student)

Variable	Characteristics	Number	Percentages(%)
University	<u>UTM</u> (2nd. yr. = 74) (3rd. yr. = 68) (4th. yr. = -)	142	31.8%
	<u>USM</u> (2nd. yr. = 35) (3rd. yr. = 39) (4th. yr. = 44)	118	26.4%
	<u>ITM</u> (2nd. yr. = 82) (3rd. yr. = 45) (4th. yr. = 60)	<u>187</u>	<u>41.8%</u>
		Total = 447	Total = 100%
Year of Study	Second year	191	42.7%
	Third year	152	34.0%
	Fourth year	<u>104</u>	<u>23.3%</u>
		Total = 447	Total = 100%
Gender	Male	290	64.9%
	Female	<u>157</u>	<u>35.1%</u>
		Total = 447	Total = 100%
Educational background (experience of the students)	SPM	284	
	STPM	84	
	Matriculation	<u>30</u>	
		No expe. = <u>396</u>	No experience = <u>88.6%</u>
	SPM+P	19	
	SPM+V	1	
	SPM+W	<u>29</u>	
		Experience = <u>51</u> Total = 447	Experience = <u>11.4%</u> Percentage = 100%

The distribution of lecturers participating in the study in terms of university was almost equal, i.e. 34.5% of lecturers from the University of Technology Malaysia (UTM), 36.0% of lecturers from the University of Science Malaysia (USM) and 32.0% of lecturers from the MARA Institute of Technology (ITM). Below (Table 7.2) is the summaries of the demographic variables of the lecturers.

Table 7.2: Summary of the demographic variables of sample (lecturer)

Variable	Name	No of respondent	population (Arch. dept. 1996)	Percentage (%)
University	UTM	10	29 (14 active 15 inactive)	34.5%
	USM	09	25 (14 active 11 inactive)	36.0%
	ITM	13	40 (28 active 12 inactive)	32.0%
Total no of respondent (lecturer) = 32			Total pop = 94	34.0%

Active - is referring to lecturers presently involve in the university

Inactive - is referring to lecturers who are not presently involve in the university i.e. they are either furthering their studies or seconded to other departments or institutions

7.1.2 What is the degree of understanding and confidence among students in construction technology?

The respondents had been asked on a basis of seven-point Likert scale, ranging from totally disagree to totally agree, indicating how much they understand the subject of construction technology. The term '*understand*' means students who understand the subject and perform well in both construction technology and design. On the other hand the term '*don't understand*' means students who face difficulties in both understanding and applying construction knowledge into designing.

The results which appear in Table 7.3, clearly illustrates the problems of learning and understanding construction technology among the students in the architectural schools under investigation. This is because out of 447 students, only 4.0% responds '*totally agree*'; 18.3% '*strongly agree*'; and 25.1%, '*slightly agree*'. In all, a total of 47.4% (212 students) of the students understood the subject. On the other hand, 35.8% of students responded '*slightly disagree*'; 9.8%, '*strongly disagree*'; and 1.3% '*totally disagree*' making a total of 47.0% (210 students) of students admitting that they don't understand or face difficulties in learning the subject. It is noted that that 5.6% (25) of students answered in the '*neutral*'. (The

answer which fall in this category is treated separately and it is not treated as an important attitude or feeling towards the answer. It is used as a measurement of uncertainty towards the question asked. Because only a small percentage is in the 'neutral' group, the researcher treated the neutral answer as an independent answer and did not put much weight on the overall result). The overall mean score recorded for this question was 4.143.

In short an almost equal number of students who 'understand' and 'don't understand' construction technology. This does augur well for the subject

The respondents were also asked to rate their competency in construction technology. The results revealed that more than half of these students were not confident with their knowledge in this subject: a small percentage of only 2.2% of the students were confident 'totally agree', 11.2% 'strongly agree', and 29.3% 'slightly agree' with the question, making a total of 42.7% or 191 students agree with the statement. Conversely, two hundred and forty two students or 54.1% were not confident with their knowledge in the subject. The mean score was 3.736 (a difference of 0.407 from question 1)

The results point to a grim situation. Approximately half of the students have problems understanding lectures. They also lack competence in construction technology in relation to design.

Below is the summary of answers given by the students on questions 1 and 2.

Table 7.3 Students' perception on their understanding and competency in construction technology

Questions	Totally disagree (1)	Strongly disagree (2)	slightly disagree (3)	Neutral (4)	Slightly agree (5)	Strongly agree (6)	Totally agree (7)	Mean	N
1) I rate my overall <u>understanding</u> in construction technology as high.	6 1.3%	44 9.8%	160 35.8%	25 5.6%	112 25.1%	82 18.3%	18 4.0%	4.143	447
2) I am <u>confident</u> of my knowledge and capability in design	27 6.0%	83 18.6%	132 29.5%	14 3.1%	131 29.3%	50 11.2%	10 2.2%	3.736	447

Evaluation were done on a 7-point Likert-type scale. 7 = totally agree, 6= strongly agree, 5 = slightly agree, 4 = neutral, 3 slightly disagree, 2= strongly disagree, 1= totally disagree.

N = Number of respondents.

The pertinent question is which group of students face this problem? A similar analysis was carried out to answer this question. Table 7.4 below summarises this analysis.

The results indicate that understanding of the subject increases as students increase their years of studies. A closer examination reveals that 69.6% of second year students answered to having understanding difficulties while 35.5% third year students responded as such. Progressively, only 22.1% of fourth year students had the same difficulties (recorded mean score of: 3.5340 from the second, 4.4145 from the third year and 4.8654 from the fourth year).

It could be hypothesised that exposure and experience in construction related areas represents a key element in the acquisitive process of construction technology. This hypothesis will be further investigated and tested in detail in Section 7.3.

On the gender basis, it was found that there was not much difference (in terms of percentages) in the understanding of the subject between the male and female students as was claimed by some of the lecturers during the interview session (Jaafar Mohamad, 1996; Mahyuddin, 1996). The results show that 44.1% of male students (i.e. 128 of 290 male students) and 52.2% of female students (i.e. 82 of 157 female students) had understanding difficulties, with mean score of 4.2103 and 4.0191 respectively. The difference between them was found to be relatively small (a difference of 8.1%)

The same measurement was carried out on the place of study (i.e. which university they go to). The results demonstrate an almost equal percentage of students from the different institutions have understanding difficulties (UTM - 50.7%; USM - 52.5%; and ITM - 40.6%).

Both gender and place of study are not important factors affecting students' performance.

From the analysis, three preliminary findings can be summarised: **first**, there is a serious problem that needs to be addressed in the learning and understanding of technical subjects, particularly in construction technology within the present architectural learning system; **second**, the magnitude of the problem apparently decreases as the years of study increases; and **third**, gender and place of study do not

affect understanding towards a substantial effect in the research. Below is the breakdown and summary of the problems.

Table 7.4 Breakdown and summary on the problems of understanding construction technology (dependent variable) based on year of study, gender and place of study (independent variables)

Description of variable (independent variables)		Frequency and percentages				
Variable	Detail of variable	Understand	Don't Understand	Neutral	Mean	N
Year of Study	Year Two	42 (22.0%)	133 (69.6%)	16 (8.4%)	3.5340	191
	Year Three	90 (59.2%)	54 (35.5%)	8 (5.3%)	4.4145	152
	Year Four	80 (76.9%)	23 (22.1%)	1 (1.0%)	4.8654	104
Gender	Male	144 (49.7%)	128 (44.1%)	18 (12.7%)	4.2103	290
	Female	68 (43.2%)	82 (52.2%)	7 (8.8%)	4.0191	157
Place of Study	UTM	52 (36.6%)	72 (50.7%)	18 (12.7%)	3.9437	142
	USM	51 (43.2%)	62 (52.5%)	5 (4.2%)	3.9237	118
	ITM	109 (58.3%)	76 (40.6%)	2 (1.1%)	4.4332	187

Evaluation was done on a 7-point Likert-type scale. Answers of 7 to 5 on the scale were construed as 'understand', answers of 3 to 1 were interpreted as 'don't understand', and 4 'neutral'.

N = Number of respondents.

7.1.3 The relationship between understanding construction technology and the designing process

The purpose of this subsection is to examine the problems resulting from lack of understanding towards construction technology from the aspect of its relationship with the designing process. This can be achieved by examining four main areas as follows:

- 1) From the way student/s do their designing i.e. whether he or she is able to think about constructional elements and design factors concurrently (in parallel) while designing.

- 2) Whether the students are able to relate construction concept, process involved and practical implementation with the designing process.
- 3) Whether they are able to perceive construction as one important design generator
- 4) Whether they emphasise construction technology in the designing process.

Respondents were asked about their perception towards the relationship between the two subjects, that is, construction technology and the designing process. They were given questions (question 3 to question 6) to be marked on the Likert scale (from 1 = totally disagree to 7 = totally agree) about the importance of learning construction and its relationship with the design process. Results from the analysis indicate that there are problems in reference to the students' failure to understand the relationship between construction technology and the designing process. This is because:

- a) Less than half of the respondents (43.6%) agreed that they are able to think about constructional elements and design factors concurrently (in parallel) during designing process (question 3), while more than fifty percent (52.6%) disagree with the statement. The mean score of 4.150 was recorded for this question. This indicates that more than half of the students do not think about construction technology concurrently while they are doing their designing process,
- b) Less than half of the respondents (43.6%) agreed with the statement that they are able to relate construction concept, process involved and practical implementation with the designing process (question 4), while (50.6%) disagree and a total mean score of 3.814 was recorded for this statement. This means that more than half of the students could not relate construction technology with the designing process,
- c) 72.0% of the students agreed on question 5 in which they believe that construction technology can be a design generator. This is very encouraging, but on the whole, the mean score is 5.047 which falls within the 'slightly agree to strongly agree' region and,

- d) More than half of the respondents (55.7%) agreed with question 6, while, (32.5%) disagreed, with a total mean score of 4.817. This means that the students believe and that construction technology is important and should be emphasise in the designing process.

The results of the four questions given above, shows that the mean score lies between '3 to 5' (slightly disagree to slightly agree) region. This indicates that there are problems in learning construction technology with reference to its relationship with the design process. Table 7.5 below is the breakdown of the answers given by the students on question 3 to 6.

Table 7.5 Students' perception of the relationship between construction technology and the designing process

Questions	Totally disagree (1)	Strongly disagree (2)	slightly disagree (3)	Neutral (4)	Slightly agree (5)	Strongly agree (6)	Totally agree (7)	Mean	N
3) While designing, I always think about construction technique	4 0.9%	59 13.2%	172 38.5%	17 3.8%	55 12.3%	106 23.7%	34 7.6%	4.150	447
4) I understand construction very well and can relate it to any design quite easily.	25 5.6%	89 19.9%	112 25.1%	26 5.8%	115 25.7%	74 16.6%	6 1.3%	3.812	447
5) I always believe construction can be a design generator	1 0.2%	12 2.7%	85 19.0%	27 6.0%	111 24.8%	163 36.5%	48 10.7%	5.047	447
6) I always emphasise technical/construction factors in my design because I believe construction is as important as other factors in design.	1 0.2%	15 3.4%	129 28.9%	53 11.9%	53 11.9%	114 25.5%	82 18.3%	4.817	447

Evaluation were done on a 7-point Likert-type scale.

7 = totally agree, 6= strongly agree, 5 = slightly agree, 4 = neutral, 3 slightly disagree, 2= strongly disagree, 1= totally disagree, N = Number of respondents.

Section 2: Analysis on learning characteristics

7.2 Comparative analysis between understanding of construction technology versus students' learning characteristic

Introduction:

The following sections presents the results of the comparison between understanding of construction technology versus learning characteristics of the students. The hypothesis related to this section will also be presented.

The purpose of this section is to investigate the first objective of the research, which is:

To identify key issues and problems relating to the learning and understanding of construction technology and their relationship with the designing process.

In this section two procedure were taken; first, the study will enumerate the differences in learning characteristics between students who *“understand” (group 1)* construction technology and students who *“don’t understand” (group 2)* construction technology and second, the study will also relate the research results to the existing literature. By presenting these differences and relating them to the existing literature, the causal reasons of the problems would be identified and understood as (Entwistle, 1990) said “student's characteristics influenced subsequent learning”. Five factors of learning characteristics to be examined were:

- Factor 1: Methods of studying (Q7 - Q12)
- Factor 2: Objectives of learning (Q13 - Q17)
- Factor 3: Designing behaviour i.e. factor/s emphasise while designing (Q18 - Q23)
- Factor 4: Motivation (Q31 - Q35)
- Factor 5: Time management.(Q36 - Q38)

The key question presented to the above factors are: Are there any differences in the learning characteristics between students who “*understand*” from those who “*don’t understand*” (students who have no problems in understanding versus students who have difficulties in understanding) construction technology?

To answer the question, the following hypothesis was tested:

HYPOTHESIS 1 (H1):

There are significant differences in the learning characteristics between students who understand (knowledgeable) and students who “*don’t understand*” (facing difficulties) construction technology.

The analysis is explored by the results of Independent-Samples T-test. The procedure is used to test that two means of independent samples (for interval data)²⁶ are not equal. In this case, the independent samples are: the two groups of students identified earlier - the students who “*understand*” construction technology (group 1) and the students who “*don’t understand*” construction technology (group 2). This analysis was used to investigate the mean differences in the learning characteristics factors (the five learning characteristics factors identified earlier) between *group 1* (N=212) and *group 2* (N=210) students. A two-tailed test at 95% Confident Interval was used to detect the differences in means between these two groups. The rule is that, if the 2-T significant is small enough and/or less than 0.05, the null hypothesis (*H₀*) that the group means are equal is rejected (Norusis, 1995). **This analysis also serves as a justification to select the variables for the correlation analysis reported later in this chapter.**

The results of the analysis for differences among mean scores of the learning characteristics factors: the methods of studying factor, objectives of learning factor, designing behaviour factor, motivation factor and time management factor with respect to differences among the sample mean scores of the respondents (student) are presented in Table 7.6. The T-value revealed the direction of the cases.

²⁶ See (Diamantopoulos and Schlegelmilch, 1997) p: 174) for a discussion on the selection of appropriate techniques for making comparison.

Table 7.6 Comparative analysis of the learning characteristics factors between students who 'understand' and those who 'don't understand' construction technology

Learning Characteristics Variables	Understand (N=212)		Don't Understand (N=210)				
	Mean (x)	SD	Mean (x)	SD	Mean diff.	T-Value	2-T Sig.
Factor 1: Methods of studying							
Reading & memorising	3.146	1.534	5.376	1.105	-2.230	-17.15	.000*
Repeat sketching on constr. detailing	3.906	1.618	5.900	0.976	-1.994	15.35	.000*
Discussion among peers	4.892	0.965	6.343	0.717	-1.451	17.53	.000*
Discussion with lecturers	6.160	0.799	4.862	0.899	1.298	15.69	.000*
Listening to delivered lectures	2.287	0.853	2.419	0.878	-0.131	-1.56	0.120
Reading books and magazines	3.358	1.668	3.376	1.463	-0.017	-0.12	0.908
Factor 2: Objectives of learning							
To pass examination	3.155	1.313	5.500	0.999	-2.344	-20.63	.000*
To be well verse in technical aspects	4.651	1.618	2.961	1.115	1.689	12.50	.000*
To see how the whole fits together	5.674	0.910	5.476	0.959	0.198	2.18	.03*
pragmatic approach	6.056	1.029	6.061	0.848	-0.005	-0.06	0.954
Perceive teacher is always right	3.127	1.338	5.361	0.898	-2.234	-20.16	.000*
Factor 3: Designing Behaviour							
Leaving technical problems to the experts	2.792	1.326	5.533	1.045	-2.741	-23.60	.000*
Using sequential design process	2.872	1.376	5.009	1.141	-2.136	-17.36	.000*
Emphasise on philosophical aspect of design	2.962	1.139	5.162	1.059	-2.199	-20.54	.000*
solving technical problems in early designing stage	6.075	0.931	5.842	1.011	0.233	2.46	.014*
Emphasise on the presentation	3.722	1.442	5.124	1.339	-1.402	-10.35	.000*
Emphasise on form and function	5.349	1.243	5.252	1.237	0.096	0.80	0.424
Factor 4: Motivation							
Perceive as an interesting subject	6.122	0.731	5.509	1.299	0.613	5.97	.000*
Enjoy learning the subject	4.669	1.402	3.114	1.333	1.555	11.68	.000*
Willing to try adventurous design	5.094	1.208	3.457	1.063	1.637	14.77	.000*
Discard a possibly flamboyant design	2.938	1.384	5.271	1.043	-2.333	-19.56	.000*
Retain to simple building form	3.391	1.543	5.361	1.265	-1.970	-14.35	.000*
Factor 5: Time management							
Work Consistently	3.547	1.509	2.995	0.986	0.551	4.45	.000*
Divide time equally bet. subjects	2.934	1.361	2.547	1.098	0.386	3.21	.001*
Work according to personal timetable	5.462	0.805	4.828	1.294	0.633	6.03	.000*

Evaluation were done on a 7-point Likert-type scale. 7 = totally agree, 6 = strongly agree, 5 = slightly agree, 4 = neutral, 3 = slightly disagree, 2 = strongly disagree, 1 = totally disagree.

SD = Standard deviation

*The test proved significant at $p < 0.05$ level using Independent T-test of Means Difference at 95% Confident Interval (95% CI).

7.2.1 Understanding construction technology versus methods of studying factor

The purpose of this subsection is to examine the differences in opinion in regarding learning or studying methods between the 'understand' group students and the 'don't understand' group students. Six factors on methods of studying/learning construction technology²⁷ were examined, they were:

- 1) Reading & memorising
- 2) Repeat sketching on construction detailing
- 3) Discussion among peers
- 4) Discussion with lecturers
- 5) Listening to delivered lectures
- 6) Reading books and magazines

With respect to the methods of studying, the Independent T-test revealed that four out of six methods of studying: reading and memorising, repeat sketching on construction detailing, constant discussion among peers and constant discussion with lecturer/s concerned, proved significant differences between the two groups of students. The results were significant at ($p < 0.05$).

- a) Significant mean differences of (-2.230) and (-1.994) on reading and memorising and repeat sketching on construction detailing respectively, were recorded between the "*understand*" group from the "*don't understand*" group students. These characteristics of studying are associated with rote learning and presumably for the purpose of examination.

"maintenance rehearsal or repetition in the act of mental or verbal repetition to hold information for some immediate purposes (examination or some form of immediate evaluation) is also known as the rote learning..." (Biehler and Snowman, 1993 : 384)

This method of studying may be useful to a certain extent for example, to be familiar with technical aspects or detailing of a building but, if it is just to be reproduced for the purpose of examination, then it will only be for surface learning which will only last for a short period of time (see chapter 4 on short-term memory).

²⁷ The method of studying/learning factors were based from literature review and exploratory interview with the students. See chapter 4 and 6.

The results imply that the method of studying using '*rote learning*' was more frequently used by the '*don't understand*' group students. This could be due to two reasons:

- i) these students are overwhelmed by a mass of information (construction technology) and due to time constraint and lack of understanding, could not find any other way of studying other than resorting to rote learning.
- ii) secondly, because the way the students are graded and evaluated i.e. by having to conform to the discipline of the syllabus of the subject, encourages the students directly or indirectly to practice memorising in order to pass the examination.

As suggested in the Gestalt theory, this act of studying (rote memorisation of facts and rules) should be avoided because according to the theory, if facts learned are memorised instead of being understood, one would not be able to apply the knowledge to new situations (Hergenhahn and Olson, 1993)

- b) With respect to discussion among peers (friends and seniors) a significant mean difference of (-1.451) was recorded between '*understand*' group from '*don't understand*' group of students. This implies that discussion among friends including their seniors are more popular within the students who are facing difficulties in understanding construction technology. On the other hand, the students who are in the '*understand*' group are more comfortable to discuss with their lecturers rather than the '*don't understand*' group, with mean difference of (1.298). On the whole, discussion on construction issues and problems are preferred by the students (mean reading of 4.892 and 6.343, within the region of '*slightly agree* to *totally agree*').
- c) The results also showed no significant difference between group 1 and group 2 students in their agreement towards listening to the delivered lecturers ($p=0.120$) as well as reading books and magazines ($p=0.908$). It can be interpreted that the conventional methods of learning through listening to lectures and reading books are equally accepted by the students.

In an effort to relate the research results to the existing literature, it was found that no empirical data in relation to comparison of the studying methods specifically

within the architectural students. However, literature and research from learning behaviour in general were plenty to support to the present research (Gagne, Briggs et al., 1992).

7.2.2 Understanding construction technology versus objectives of learning

The purpose of this subsection is to examine the differences in opinion in terms of the personal learning objectives between the 'understand' group of students and the 'don't understand' group of students. Five factors of personal objectives of learning construction technology²⁸ were examined, they were:

- 1) To pass examination
- 2) To be well verse in technical aspects
- 3) To see how the whole fits together
- 4) Pragmatic approach
- 5) Perceiving teacher/lecturer as always right

The Independent T-test revealed that four out of five factors on the objectives of learning, i.e. to pass examination, to be well verse in technical aspects of a building, to see how the whole fits together and perceiving the teacher as always right (never put doubts on the teacher's knowledge), proved that means differences between the groups were statistically significant at ($p < 0.05$).

- a) Significant mean differences of (-2.344) and (-2.234) are recorded on the objectives of learning to pass examination and perceiving teacher as always right. This shows that students from the '*understand*' group do not agree with the objective of learning just for the sake of passing the examination and perceiving teacher as always right.

²⁸ The learning objectives factors were based from literature review and exploratory interview with the students. See chapter 4 and 6.

- b) Their objectives (students from '*understand*' group) are more towards being well-versed in technical aspects of the buildings and to see how the whole system of construction works on every buildings that they encountered with (means difference of 1.689 and 0.198). From the data we can say that the students who understand construction technology in general adopted the long-term learning objectives rather than the students from the don't '*understand*' group.

However, the study also shows that there is no significant difference between group 1 and group 2 students regarding objective of learning from the aspect of pragmatic approach. The significant level of ($p=0.954$) was far above the cut-off point of 0.05 percent at 5 percent significant level. The result can be interpreted that the students from both group 1 and group 2 agree on learning construction technology from its pragmatic approach. The mean value recorded was 6.056 and 6.061 respectively, which is in the region of 'strongly agree' to '*totally agree*'.

In an effort to relate the research results to existing literature, no empirical data was found in relation to comparison of the objectives of learning especially within the architectural students. However, evidence from the interview (please refer to Chapter 6) revealed that learning construction technology from its pragmatic approach is needed by majority of the students (interviewed from: (Arshad, 1996; Hamidun, 1996; Jaafar Mohamad, 1996; Kamisan, 1996; Mahyuddin, 1996; Mohd Jusan, 1996). Agreeing with this, the lecturers too, see this as an effective approach to teaching construction technology.

7.2.3 Understanding construction technology versus designing behaviour factor

Items concerning designing from questions (Q18 - Q23) were based on design criteria emphasised during designing activity. The attitude of students towards technical aspects in design for example, by leaving the technical aspects of design to the 'experts' i.e. the lecturers, students could put extra effort on design philosophy, building form and graphic presentation more than any other designing process activities. Six factors on designing behaviour (especially in relation to the integration of construction technology into the designing process) were examined, they were:

- 1) Leaving technical problems to the experts
- 2) Using sequential design process
- 3) Emphasise on philosophical aspect of design
- 4) solving technical problems in early designing stage
- 5) Emphasise on the presentation
- 6) Emphasise on form and function

Students were tested to find out whether there are significant differences in their behaviour regarding their designing activity or behaviour which could lead us to better understand the problems in learning construction technology especially when integrating it into the designing process. Results of the tests and the significance value of each test is shown in table 7.6.

- a) With respect to the test, five out of six activities in the designing process served to differentiate between the knowledgeable students (*'understand'* group) from the less knowledgeable students (*'don't understand'* group). They were: leaving technical problems to the experts, using sequential design process, emphasising philosophical aspects of design, solving technical problems in early designing stage and emphasising on the presentation (graphics and verbal) of design. The Independent T-test proved significant differences of (-2.741), (-2.136), (-2.199), (-1.402) and (0.233) between the two groups. The results proves significant at ($p < 0.05$) level. This imply that in general, group 2 (*'don't understand'*) students tend to agree with the following designing behaviour:
 - i) follow sequential designing process,
 - ii) spend most of the designing time on the philosophical aspect of design such thinking on ideas and forms of a building and less on other aspects of design which are equally important,
 - iii) spend most of their time on graphic presentation and
 - iv) Due to these designing behaviours, usually they tend to push aside the importance of **technical aspects** (construction technology, structure and other building regulations) by assuming that these problems can be solved at the end of the projects or can be handed over to the

'specialist'. In this situation the lecturer in the studio are treated as the specialist or the experts (Neel, 1969; Dutton, 1987).

- b) However, the study also showed that there is no significant difference between group 1 and group 2 students regarding the emphasis on form and function of the building designed. The significant level of ($p=0.424$) was far above the cut-off point of 0.05 percent at 5 percent significant level. The result can be interpreted that the students from both, group 1 and group 2, tend to agree on emphasising the form and functional aspect of a building when they are given the task to design (the mean value recorded was 5.349 and 5.349, which is in the 'slightly agree to *strongly agree*').
- c) The test also revealed an interesting finding whereby, students from the '*understand*' group agree on solving all the technical problems in the early designing stage. The mean difference between the '*understand*' and the '*don't understand*' group on this factor is (0.233) at significant level of ($p<0.05$). This imply that in general, students from the '*understand*' group tend to agree on the importance of integrating technical aspects and design at the early stage of the designing process.

As stressed in a recent research by (Embi, 1997), all the technical aspects of design, including fire regulation requirements, construction, structure and environmental factors, ought to be integrated and solved at the early stage of the design process.

7.2.4 Understanding construction technology versus motivation

This subsection intends to elicit indicators that there are problems regarding learning and understanding of construction technology especially in relation to its application in the designing process, which was obviously revealed in the motivation of the students. High motivation can be induced into individuals when they experienced a cognitive disequilibrium or a desire to find information or solutions in an intrinsic form of motivation - whereby learning occurs for its own sake (Biehler and Snowman, 1993). Thus when a student is willing to try adventurous design for example, it means he/she is experiencing a cognitive disequilibrium. The aim of the

test, is to find out whether this intrinsic motivation exist within the two groups of students - the students who '*understand*' (group 1) and the students who '*don't. understand*' (group 2) concerning construction technology. Items concerning motivation from questions (Q31 - Q35) were based on personal motivation towards understanding construction technology in relation to the design process. They were:

- 1) Perceiving construction technology as an interesting subject
- 2) Enjoying learning construction technology
- 3) Willing to try adventurous design
- 4) Discarding a possibly flamboyant design
- 5) Retaining to simple building form

With respect to the Independent T-test method for comparison analysis (see Table 7.6) on the five motivation factors, show that group 1 (those who understand construction technology) and group 2 (those who don't understand construction technology) are statistically different from each other as explained below:

- a) The Independent T-test show mean differences of (0.613), (1.555), and (1.637), on the following motivation factors tested: perceiving construction technology as an interesting subject, enjoying learning construction technology and willingness to try adventurous design respectively. The results prove significant at ($p < 0.05$) level.
- b) On the other hand, the mean differences of (-2.333) and (-1.970) between group 1 and group 2 were recorded on: discarding a possibly flamboyant design when accounted with construction problem/s and retaining to simple building form respectively. The results prove significant at ($p < 0.05$) level.

The results imply that, successful achievement or experiences (experienced by students from group 1) will motivate them to learn more. In other words, when the students know and understand what they learn, they will be motivated to learn and discover more about the subject concerned²⁹. On the other hand, when the students are faced with difficulties and not able to master the task, motivation would be decreased hence, performance would be affected. This result implies that when

²⁹ See (Biehler and Snowman, 1993) p: 524 on Cognitive interpretation of motivation

students are facing difficulties in understanding construction technology, their motivation to explore new design ideas would decrease as they are afraid to make mistake that would jeopardise their design.

In general, the results revealed that, students from group 1 (understand), are more motivated to learn construction technology than the students from group 2 (don't understand). As addressed by (Brophy, 1983a; Brophy, 1983b) motivation is likely to be optimal when students know they have the skills to master a task and value those skills. As forwarded by (Hetherington, 1995) in his paper "*the project based approach in architectural education*" said that, motivation arising from the fact that the students learn what they need to know for immediate application to the solution of a design problem ...". Similarly, the authors on adult learning, (Knowles, 1970) and (Rogers, 1986), focused the study of motivation on the value of learning for its own sake and not for any physical/behavioural reward.

7.2.5 Understanding construction technology versus time-management factor

The purpose of this subsection is to examine the different views regarding personal time management between the '*understand*' group students and the '*don't understand*' group students. Three factors to determine whether time management³⁰ are being practiced by the students were examined, they were:

- 1) Consistent work
- 2) Time divided equally between subjects
- 3) Work according to personal timetable

With respect to the Independent T-test method for comparison analysis on the time management factors, group 1 (those who understand construction technology) and group 2 (those who don't understand construction technology) are statistically different from each other. The Independent T-test shows that mean differences of (0.551), (0.386) and (0.633) are for: work consistency (i.e. discipline on study time),

³⁰ The time management factors were based from (Anthony, 1991) and exploratory interview with the students. See chapter 4 and 6.

divide time equally between subjects and work according to own time table respectively. The results prove to be significant at ($p < 0.05$) level.

This imply that students from group 1 (knowledgeable in construction technology) agreed on factors relating to time management compared to students from group 2 (students with difficulties in construction technology). Even though, the result reveal that there are differences between the two groups but on the aspects of consistency in working time and divide time equally, the answers shown are in the lower scales (between 2 to 4, i.e. 'strongly disagree to neutral') hence, these reveal that time management are still unpopular with the students.

In an effort to relate the research results to the existing literature, it was found that no empirical research specifically on time management within the architectural students. However, issues on time management have long been discussed in the school of architecture. Students argued that:

“the creative process can occur at any moment of the day or night - it assured us that design defies scheduling...”

Even some designers believed that planning their work out on a stiff schedule stifles their creativity (Anthony, 1991), but the researcher is quite convinced (partly due to her personal experience as a student herself and as a lecturer) that those students who can manage their time well, perform much better than their counterparts. As this is only an exploratory research particularly regarding this issue, the researcher suggested that a more precise investigation on this aspect has to be carried out.

Overall, the results from this section of the study, that is, from the aspects of comparing the understanding of construction technology factor with learning characteristics factors of the students under investigation, are consistent with the expectations, i.e. we reject the null hypothesis (H_0). In other words, we can conclude that there are statistically significant differences between the two groups of students (group 1, which understand construction technology and group 2, which don't understand or are facing difficulties in understanding construction technology) based on their learning characteristics factors. The findings revealed the first step in identifying key causes to the problems of learning and understanding construction technology in relation to the designing process.

Section 3: Analysis on prior learning experience

7.3.1 Comparative analysis on prior experience versus understanding construction technology and competency in the designing process

Students with prior learning experience performed better than their counterparts (Albrecht, 1988; Achtenhagen, 1995; Avis, 1995). Based on this fact, we assume that having adequate prior knowledge may reflect the higher ability to visualise and rationalise the workability and feasibility of the building designed; therefore, better problem solving skills and swiftness in decision making. This interpretation therefore, affects the overall performance of the students.

Although prior experience is potentially important for the pedagogical development of architectural curriculum, there is little by way of empirical research that helps us to understand this presumption. Our knowledge on how prior design training and prior professional training in construction technology affect performance on the design process remains speculative.

The focus of this section is to respond to the query concerning the effect of prior knowledge on performance of the students mentioned above. For the benefit of this research, performance in this case is measured from the understanding and competency of students in construction technology and design. To demonstrate this, the following hypotheses were tested:

HYPOTHESES :

2(a): Students with prior experience tend to understand construction technology better than the students without prior experience

2(b): Students with prior experience tend to show competency in the designing process compared to the students without prior experience

The analysis is explored by the results of Independent-Samples T-test. The procedure is used to prove that two means of independent samples are not equal. In this case, the independent samples are: the students with prior experience versus those

without prior experience. Two groups of students in reference to prior experience were identified. They were students who enter university using the required qualifications in addition to prior professional training and secondly, those who enter university using the required qualifications plus working experience in architectural related areas. This group of students were identified as '*experience*' and those who enter university using the basic academic qualification (i.e. right after finishing high school) were identified as '*non-experience*' students.

The number of respondents identified into these categories were 51 and 396 respectively (detail on how categorisation of the students based on prior experience is explained in chapter 5). Because the number of respondents in the former group is too low compared to the latter group, further division within the '*experience*' category is not permitted (for example, division between group prior professional training and prior working experience). A two-tailed test at 95% Confident Interval was used to detect any difference in means between these two groups. The rule is that, if the 2-T significant is small enough and/or less than 0.05, the null hypothesis (*Ho*) that the group means are equal is rejected (Norusis, 1995). The results of the test is shown on Table 7.7 below:

Table 7.7: A comparative analysis on prior experience versus understanding of construction technology and competency in the designing process

Questions	Prior experience based on entry qualification						
	++Experience (N=51)		+Non-experience (N=396)		Mean diff.	T-Value	2-T Sig.
	Mean (x)	SD	Mean (x)	SD			
Q1: I rate my overall understanding in construction technology as high	5.8627	0.872	3.9217	1.400	1.9410	13.77	.000*
Q2: I am confident with my knowledge and capability in design.	5.7843	0.673	3.4722	1.452	2.3121	15.35	.000*

Evaluation were done on a 7-point Likert-type scale. 7 = totally agree, 6 = strongly agree, 5 = slightly agree, 4 = neutral, 3 = slightly disagree, 2 = strongly disagree, 1 = totally disagree.

SD = Standard deviation

* The test proved significant at $p < 0.05$ level using Independent T-test of Means Difference at 95% Confident Interval (95% CI).

Entry qualification:

+ SPM, STPM, Matriculation = Non Experience students

++ SPM+V, SPM+P, SPM+W = Experience students (i.e. students with some training/working experience on construction or architectural related training experience)

The hypothesis is explored by the results of the Independent T-test. The aim of the measurement is to find out the mean difference in reference to understanding construction technology and competency in design, between the identified categories of students based on their prior experience³¹: 'experience' students (N=51) and 'non-experience' group students (396). The results clearly revealed differences in terms of the students' perception towards understanding and competency in both construction technology and design between the students with prior experience and those without prior experience.

- a) The results indicate that a mean difference of (1.9410) was recorded on understanding construction technology between the 'experience' students and the 'non-experience' students. The difference was statistically significant with a p-value of ($p=0.000$) in the reading, which was far below the cut-off point of 0.05 percent at 5 percent significant level. The null hypothesis is therefore rejected.
- b) The results concerning the aspect of competency shows a mean difference of (2.3121) in doing the design, between the 'experience' students and the 'non-experience' students. The difference was statistically significant with a p-value of ($p=0.000$) in the readings, which are far below the cut-off point of 0.05 percent at 5 percent significant level. The null hypothesis is therefore rejected.

The majority of students who have some prior design training or prior professional training in building construction believe that they understand construction technology better and are competent in design. Thus, from this analysis it is safe to conclude that students with prior learning experience performed better than their counterparts.(The test on these two factors regarding performance are discussed in section 5)

³¹ See page 125 of chapter 5 on transformation of data and see page 144 on detail discription of the demographic variables.

7.3.2: A relationship analysis on prior experience versus understanding in construction technology and competency in the designing process

The focus of this subsection is to respond to the second query concerning prior experience in the aspect of competency of the students in the designing process. Based on the knowledge that prior experience is useful in the understanding of the theoretical relationship of construction technology in the design process, we therefore assume that they should be positively correlated with the understanding of construction technology and competency in the design process. The hypothesis related to this section is presented below:

HYPOTHESIS 2(c)

Understanding on construction technology and competency in the designing process are positively correlated with prior experience (exposure and experiences in architectural knowledge) of the student

This hypothesis is explored by the results of the Pearson-product moment correlation test. The analysis was conducted to prove the significance of this association by correlating the prior experience factors (year of study and the entry qualification) with understanding construction technology (Q1) and competency in the designing process (Q2). The analysis of the results are explained below:

- a) The result show a positive correlation of ($r=0.3662$) between year of study (Question b) and understanding of construction technology (Q1) and a positive correlation of ($r=0.2699$) between years of study (Question b) and competency in the designing process (Q2);
- b) A positive correlation of ($r=0.3829$) between entry qualification (Question d) and understanding of construction technology (Q1) and a positive correlation of ($r=0.3810$) between entry qualification (Question d) and competency in the designing process (Q2).

However, all the correlations proved significant using a *one tailed Person-product moment correlation test* .at the probability of ($p<0.01$). Thus, the null hypotheses are rejected. The results of the test are shown on Table 7.8 below:

Table 7.8 Correlation between prior experience: year of study and entry qualification with understanding of construction technology and competency in the designing process

understanding construction technology and competency in the designing process	*Prior experience factor	
	Question (b): Please specify your present year of study	Question (d): Please specify your qualification when entering the university.
Q1: I rate my overall understanding in construction technology as high.	$r = 0.3662$ $p = 0.000$ $N = 447$	$r = 0.3829$ $p = 0.000$ $N = 447$
Q2: I am confident on my knowledge and capability in design.	$r = 0.2699$ $p = 0.000$ $N = 447$	$r = 0.3810$ $p = 0.000$ $N = 447$

* Prior experience refer to: 1) The year the students study in the university and 2)Entry qualification used by students to enroll themselves in the university.

r = Pearson correlation coefficient

p = probability value

N = number of respondents

The above results proved strongly that prior experience in construction technology (exposure to pragmatic experience) is important in providing a better understanding (meaningful learning) on the aspects of relating construction theories with the designing process. Thus, the hypothesis is supported.

The results do support several research findings performed on the influence and application of experience during design problem solving such as by (Verma, 1997), (Göker, 1997) and (Newman, 1978). In an empirical investigation, Verma, (1997) used the results from Scheffe's S-method (using one-way ANOVA test) for comparing the understanding on theoretical questions in design between three identified types of prior experiences tested on 49 students. The prior experience was based on those who have professional design experience, those with other professional experience and those without any professional experience. The results from the test concluded that there are statistically significant differences between the three groups concerning understanding in design. This confirmed in her research the fact that students' knowledge of design methods was higher with professional experience as compared to without experience.

Contradictory to the above statement, Rambow (1995) believed that the problem-solving ability between the experienced architects and the non-experienced architecture students are not being influenced by their psychological past experience but due to the nature of architectural training itself. According to him, architectural training itself is *case study* in nature and *inducing experiences*, thus, in his experiment, the empirical difference between the experienced architect and the non experienced students was not proved significant on the problem solving test (designing the given floor plan)³².

Nevertheless, several other experiments and research in this area like (Akin, 1986; Göker, 1997) and Schon and Wiggins (1992) agreed with the fact that prior experience contribute to better learning performance. In an experiment by (Göker, 1997) shows that, while novices try to solve assignments through deductive reasoning, experts prefer to apply their experience directly. Göker used an electrophysiological experiments to indicate that the regions activated in the human brain during problem solving vary according to the experience a person has.

In another experiment (which support this finding) by Akin, (1986) show that the novice designer started a design from a design requirements (partial details) to abstract concept and additively generated a solution, whereas, the expert designer developed a scenario (a large chunk of functional knowledge) to capture broad features of the design. Schon and Wiggins (1992) explain this by stating that the novice designer begins to work in one domain, however, the expert or experience designer can work simultaneously in many domains.

Overall, the results from investigation that is, from the aspects of comparing and correlating prior experiences with understanding and competency in construction technology in the designing process and with the support from the literature review, are consistent with the expectations, i.e. we reject the null hypotheses. In other words, we can conclude that prior professional training or working experience in architectural related areas are invaluable in the architectural learning system particularly in relating theoretical knowledge like construction theory into the designing process.

³² For further reading, please refer to the experiment carried by Rambow, (1995)

Section 4: Analysis on methods of teaching construction technology

Introduction:

The purpose of this section is to investigate the second objective of the research, which is:

To investigate whether there is a gap between the learning methods preferred by the students and the teaching methods used by the lecturers in the present architectural learning system, which may be one of the key causes to the problems of integrating construction technology into the design process.

There are at least seven methods of teaching construction technology practice in the architectural school (please refer to teaching methods in architectural school on Chapter 3). They are:

- 1) Verbal lecture
- 2) Lecture with the aid of overheard projector (lect. + OHP)
- 3) Lecture with slide show (lect. + slide)
- 4) Lecture with three dimensional illustrations (lect. + 3D illus.)
- 5) Model making on building construction (model making)
- 6) Showing videos on real construction work (video)
- 7) Teaching from site visit (site visit)

Some of these methods are favoured and perceived to be effective by the students. On the other hand, they could be unpopular among the lecturers as these methods could possibly be difficult to handle and cumbersome to the lecturers concerned. The investigation focused on the observed differences on **first**, the preferences of the teaching methods among the lecturers and **second**, the observed differences with regard to preferences on the methods of teaching construction technology between the students versus the lecturers.

7.4.1: A comparative analysis on the methods of teaching construction technology among the lecturers

The respondents (the lecturers) were asked to indicate how much they agree based on a seven-point Likert scale (from 1 = totally disagree to 7 = totally agree), on two types of questions:

- 1) The teaching methods which they perceive to be suitable/effective for teaching construction technology and
- 2) The teaching methods frequently carried out by them.

The aim is to identify the teaching methods ideally preferred by the lecturers and compare them with the actual methods carried out by them. From this analysis, we can identify the most common method/s of teaching construction technology practice among the lecturers in the architectural school under investigation. Later in the chapter, we will justify the reason/s for certain method/s of teaching construction technology not frequently being carried out. The hypothesis to be tested is:

HYPOTHESIS 3(a)

Verbal lecturing (with/without the aid of overhead projector or slides shows) is a more frequent practice among lecturers than teaching which promotes experience (such as with 3D illustrations, using videos and teaching from construction site).

A paired T-test was performed on each of the seven teaching methods identified above. Table 7.9 summarises the results of the test. The last column of the table shows the significance of the differences between the teaching methods perceived to be ideal for teaching construction technology versus the teaching methods frequently carried out by the lecturers.

- a) The results of the test, did not show any significant difference from 3 out of 7 methods of teaching construction technology being tested ($p > 0.05$). They are:

- i) Verbal lecturing
- ii) Lecturing with the aid of overhead projector (Lect + OHP)
- iii) Lecturing with some slides showing construction techniques or materials (Lect. + Slides).

However, these results had been consistent with the expectations. This implies that the conventional teaching methods (i.e. verbal lecturing, lecturing with the aid of the overhead projector and lecturing with regularly showing slides) were constantly being used in teaching construction technology in the present architectural school than the teaching methods which apply video, 3-D illustration, model making and site visit (these methods would presumably promote experience). This supports the hypothesis that teaching through lecturing is more popular among the lecturers than teaching which presumably promotes experiential learning. The detail results of the test is shown on Table 7.9 below:

Table 7.9: Comparison of the lecturer's method of teaching construction technology perceive to be ideal versus the actual method frequently carry out

Teaching Methods	Teaching method perceive ideal/effective (Mean)	Teaching method frequently carried out (Mean)	Diff.	t-value	df	2-tail sig.
Verbal lecture	6.09	6.34	-0.25	-1.28	31	0.211
Lect. + OHP	5.65	4.88	0.78	1.53	31	0.135
Lect. + Slides	4.91	4.81	0.093	0.41	31	0.687
Lect. + 3D-Illus.	5.25	4.4	0.843	3.83	31	0.001*
Model making	5.34	2.47	2.875	16.13	31	0.000*
Video	5.22	2.03	3.187	18.07	31	0.000*
Site visit	6.25	2.72	3.531	18.54	31	0.000*

Evaluation were done on a 7-point Likert-type scale. 7 = totally agree, 6= strongly agree, 5 = slightly agree, 4 = neutral, 3 slightly disagree, 2= strongly disagree, 1= totally disagree.

* The test proved significant at $p < 0.05$ level using Pair T- test at 95% at Confident Interval (95% CI).

df = degree of freedom

Diff = means difference

In an effort to relate the research results to the existing literature, it was found that no empirical research was found especially on comparative analysis of the methods of teaching construction technology among architectural lecturers.

However, issues on teaching methods which promote experience were accepted by the lecturers to be the most effective means to generate better understanding in the aspect of learning construction technology. Ideally, this is believed to be the absolute concept when one is designing a learning/teaching aid or instruction (Dennison and Kirk, 1990).

7.4.2: A comparative analysis on the methods of teaching construction technology preferred by the students versus the lecturers

With regard to preferences on the methods of teaching construction technology between lecturers and students, the following hypothesis is tested:

HYPOTHESIS 4

There is a significant difference in preference on the methods of teaching construction technology between lecturers and students.

The hypothesis is explored by the results of Independent-Samples T-test. The procedure which is used to prove the hypothesis that the two means are not equal. In this case, the independent samples are the students' group and the lecturers' group. The analysis was used to determine: the mean differences in preferences on teaching methods used between the students ($n=447$) and the lecturers ($n=32$) and consequently, ranking these teaching methods in order of preferences, from the two groups. A two-tailed test at 95% Confident Interval was used to detect the difference in means between these two groups.

Results summarised in Table 7.10 show differences in preferences on the methods of teaching construction technology between the students versus the lecturers. The differences between these two groups were statistically significant at ($p<0.05$) in most of the cases except for the teaching method using three dimensional (3-D) illustrations (student mean = 4.5011, lecturer mean = 4.6875 and the p-value was 0.262 which is above 5 per cent significant level). Overall, the result reject the null hypothesis (H_0 = no significant difference in preference on the methods of teaching construction technology between lecturers and students) except for the teaching method using three dimensional illustration (3-D Illustration).

For the benefit of this research, an attempt to rank these teaching methods in terms of preferences exhibited by the students and the lecturers are made. For the highest preferred teaching method the ranking is given as number 1, the second highest preferred is given number 2 and the least preferred is ranked number 7. The results show in terms of numerical ranking, an interesting finding between the teaching methods preferred by the students and the lecturers. The ranking shows an inverse relationship between the variables. For example, when the students prefer teaching construction technology through site learning, it is totally in contrast to what is frequently carried out by the lecturers. (Similar situation as in the case of learning through verbal lecture which is the least preferred teaching method by the students, but, seems to be the top priority teaching method among the lecturers). Obviously, this shows that **there is a gap between the learning methods preferred by the students and the teaching methods used by the lecturers** in the present architectural learning system. However, this learning gap should be recognised and in turn narrowed. Details of the results showing the sample mean, the mean differences and ranking given in reference to the mean are shown on Table 7.10 below:

Table 7.10: Comparison on the methods of teaching construction technology preferred by the students versus the lecturers.

Teaching Methods	Students (n=447)			Lecturers (n=32)					
	Sample mean (x)	Std. dev. (SD)	Rank	Sample mean (x)	Std. dev (SD)	Rank	Mean Diff.	T-Value	2-T Sig.
Verbal lecture	3.1655	1.295	1	6.3438	0.787	7	-3.1782	-20.9	.000*
Lect. + OHP	3.1723	1.302	2	5.6250	0.871	6	-2.4527	-14.8	.000*
Lect. + Slides	4.3535	1.339	3	5.0938	0.689	5	-0.7403	-5.39	.000*
Lect. + 3D-Illus.	4.5011	1.314	4	4.6875	0.859	4	-0.1864	-1.14	.262
Model making	5.2908	1.300	5	2.9688	1.121	3	2.3221	11.19	.000*
Video	5.8434	1.368	6	2.3438	1.234	1	3.4997	14.06	.000*
Site visit	6.0537	1.252	7	2.7188	1.143	2	3.3349	14.64	.000*

Evaluation were done on a 7-point Likert-type scale. 7 = totally agree, 6= strongly agree, 5 = slightly agree, 4 = neutral, 3 slightly disagree, 2= strongly disagree, 1= totally disagree.

* The test proved significant at $p < 0.05$ level using Independent T-test of Means Difference at 95% Confident Interval (95% CI).

Note:

Ranking is based on the means: the higher the number the more preferred it is.

The implication from this data is that the teaching methods preferred by the students are not frequently carried out by the lecturers. This is true in most cases. For example, the students prefer to learn from the site but this method is not capable of being carried out frequently by the lecturers since it involves time, safety precaution and has to go through some procedures in getting permission to enter the construction site. In addition, there are difficulties involved to get appropriate site as some of the construction sites at the time are far from the university. In the case of teaching with video, most of the video documents are found to be outdated and most of the examples shown are not from the local building constructions. Besides, using video is also believed to be time consuming (interview findings from: Arshad, 1996; Hamidun, 1996; Jaafar Mohamad, 1996; Kamisan, 1996; Mahyuddin, 1996; Mohd Jusan, 1996), thus making it unpopular.

Section 5: Understanding construction technology and performance

7.5 An analysis of the relationship between understanding construction technology and students' performance in the designing process

The purpose of this section is to find out whether there exists any relationship between understanding construction technology and the performance of the students in the designing process and if so, what is the nature and strength of their relationship. It is anticipated that from the analysis that the researcher can establish the basic learning requirements in order to bridge the gap between the understanding of construction technology and the performance in the designing process. On top of that, the analysis could also revealed the importance of identifying the relationship. To carry out the above procedure, the following is the main hypothesis to be tested:

HYPOTHESIS 5

Understanding of construction technology is positively correlated with performance of the designing process.

In order to test this hypothesis, the following sub-hypothesis were needed to be tested:

- H5(a): Understanding construction technology is positively correlated with confidence in design
- H5(b): Understanding construction technology is positively correlated with the ability to think about construction and design (theory and practical) concurrently.
- H5(c): Understanding construction technology is positively correlated with the ability to relate construction method with design.
- H5(d): Understanding construction technology is positively correlated with the perception that construction technology is an important factor in design and can be used as a design generator.

H5(e): Understanding construction technology is positively correlated with the perception that it is one of the major elements of the whole body of design.

H5(f): Understanding construction technology is positively correlated with superior design results.

These hypotheses are explored by the results of the *Pearson product of moment coefficient (Pearson r) test*. Results revealed that correlation coefficient between understanding of construction technology and performance in design, on average falls within the range of $r= 0.50$ to 0.80 . That is, they fall in the range of moderate to strong relationship (please refer to Table 7.11 below)

Table 7.11: Correlation between understanding construction technology (Q1) and performance on the designing process .

Performance factors on the designing process	Correlation Coefficient (r)	Significant (p)
Q2: Confidence in design	0.7897	0.000*
Q3: Ability to think constr. and design concurrently	0.6984	0.000*
Q4: Ability to relate constr. method into design	0.7117	0.000*
Q5: Perceived construction technology as a design generator	0.5573	0.000*
Q6: Perceived constr. as a major component in the whole body of design.	0.6685	0.000*
Overall students' marks	0.4781	0.000*

Note: All the correlation were positive and the number of valid cases were (N=447) that means no missing cases in each of the correlation.

r = Pearson correlation coefficient

p = actual probability value

* The test proved significant at $p<0.05$ level at 95% Confident Interval (95% CI).

- a) In testing hypothesis H5(a): Understanding construction technology is positively correlated with confidence in design, the result revealed correlation coefficient of ($r=0.7897$), which falls within the range of ‘strong’ positive correlation. This implies that, as understanding of construction technology increases, the level of confidence among students in the designing process increases. This is not surprising, because, if students understood the concept of learning construction technology, obviously they will be more able to apply them in the design.

- b) In testing hypothesis H5(b): Understanding construction technology is positively correlated with the ability to think of construction and design (theory and practical) concurrently, the results revealed correlation coefficient of ($r=0.6984$), which falls within the range of 'moderate to strong' positive correlation. The result also revealed that the correlation is highly significance ($p<0.001$). This implies that as understanding of construction technology increases, the ability to think concurrently on constructional factors and designing factors increases. This is exactly what has been forwarded by (Lawson and Roberts, 1991) in their paper as the modes of thought. In his recent paper (Lawson, 1993) clearly describes this relationship as the parallel lines of thought which is a cognitive characteristic of the designing process.
- c) In testing hypothesis H5(c): Understanding construction technology is positively correlated with the ability to relate construction method with the designing process. The results show that they were positively correlated and the strength of the relationship falls within the range of 'moderate to strong' relationship where ($r=0.7117$). This indicates that the ability to relate construction method is highly dependent on the overall understanding in construction techniques applied in design. This correlation is very important as it implies that designing process has a lot to do with the knowledge on construction technology. It also means knowledge on pragmatic application in teaching construction technology is highly essential in architectural education. The result also revealed that the correlation is highly significance ($p<0.001$).
- d) The perception of a learner towards a subject is important in deciding his/her commitment towards the subject. For example, if a student perceives construction technology as a very important subject and understands it as one of the designing generators in his/her architectural education, then this implies that the person understand the concept of learning construction technology. In this hypothesis H5(d) understanding construction technology is positively correlated with the perception that it is an important factor in design and can be use as a design generator. The correlation between understanding of construction technology and perceived construction technology as design generator, is very important in determining the potential creativity and flexibility of the learner in exercising designing process.

The results revealed that they were positively correlated and the strength of the relationship falls within the range of 'moderate' relationship where ($r=0.5573$). However, the result is slightly lower than the other tests. This presumably, could be explained by two reasons:

Firstly, a greater number of the respondents (42.7%) were in the second year of their study in the university; therefore, were not very experienced and thus unable to see the potential of construction technology.

Secondly, it may be due to the fact that most of the students (88.6%) in the university were directly admitted from the upper secondary school, that is soon after completion of their SPM or STPM (please refer to Figure 7.1 for statistical data of the respondents).

They lack in exposure to the actual work on buildings such as case study or practical training. They haven't had the opportunity yet to explore and see the hidden potentials of this subject (construction technology). Due to this, most of them are tied to their pre-set ideas on design and construction.

- e) In testing hypothesis H5(e): Understanding construction technology is positively correlated with the perception that it is one of the major element of the whole body of design. The difference between hypothesis H5(d) and hypothesis H5(e), is that in the latter, it is assumed that other design components such as environmental factor, services, structure, function, form and space, circulation etc., apart from construction were treated as part of the whole design. By appreciating these factors, the designer has to accommodate these design components simultaneously while carrying out the designing process.

The results revealed that the correlation were positive and the strength of the relationship falls within the range of '*moderate*' relationship where ($r=0.6685$). This implies that those who understand and appreciate construction technology knowledge would understand the other designing elements (components) which are required to be simultaneously involved while carrying out the designing process. Upon analysis of previous literature, in their paper Lawson and Roberts, (1991) stated:

“ ... firstly the building may be seen as a collection of components such as walls, windows, doors, floors, roofs and so on. Secondly, the designer may think of the building in terms of envelopes such as rooms, courtyards, Designers [...] often discuss their ideas in terms of floors, elevations and sections, which we may think of as strata. Designers can also seen and organise their thinking about the building along functional system lines. Thus building features may belong to structural or cladding systems, or be seen as part of the services or circulation systems.”

(Lawson and Roberts, 1991: 103)

Therefore, this result confirmed the study carried out by the above authors.

- f) Hypothesis H5(f): Understanding of construction technology is positively correlated with a superior designing performance.

In this hypothesis testing, list of students' result were obtained from the course tutor from each university. The correlation is carried out between Q1: understanding construction technology and the actual results obtained (the final grades awarded to these students). The result reveals that the correlation is positive and the strength of the relationship falls within the range of 'moderate' relationship where ($r=0.4781$). This implies that those who understand and appreciate construction technology knowledge would perform well in their design projects as well.

However, all the correlation tests proved significant using a *one tailed Pearson product moment correlation test* .at the probability of $p<0.01$. Thus, the null hypotheses are rejected.

From the testing of six sub-hypothesis, it clearly shows that there is a positive correlation between understanding construction technology and the performance in the designing process (the correlation table were shown on Table 7.11). This implies that understanding construction technology is interrelated with understanding of its application into the designing process. Thus, the hypothesis that understanding of construction technology is positively correlated with performance of the designing process is supported.

7.7 Summary

This chapter presented a description of the study's variables and the research findings of hypotheses testing that were developed in chapter five. In Section 1, the research describes the demographic background of the respondents (students and lecturers) involved in the investigation, the perception of the respondents regarding the problems, the breakdown of the problems based on respondents' background and the general observations on the students' perception regarding the relationship between understanding construction technology and the designing process.

In Section 2, the research identifies learning characteristics of the students which were distinctively influencing the learning methods of each individual students. To the researcher's opinion these learning characteristics have to be identified (five main factors on learning characteristics were identified which are: methods of studying, objectives of learning, designing behaviour, motivation and time management) through hypotheses testing and relating them to the existing literature so that the reasons for the problems would be highlighted and understood.

In Section 3, the research presented analysis based on the respondents' educational and training background. This data was obtained based on the students' entry qualification into the university, which is then categorised into students with experience and those without experience (experience in this context is referring to some training background in architectural related fields). The results presented have been supported by several other similar researches on the influence of experience or prior knowledge encountered during problem solving in architectural education .

Teaching method is one of the main area contributed to this research. In Section 4, the research attempts to investigate the gap between the teaching methods preferred by the students versus the teaching methods carried out by the lecturers. The aim is to highlight the gap present between the students and the lecturers from the aspect of learning/teaching preferences, which may be one of the causal reasons contributing to the problems. The results were presented through hypotheses testing.

Finally, to tie up the findings, in Section 5, understanding construction technology was tested with performance of the students by correlating understanding construction with six other factors on performance in design including students' final year design marks. The results revealed positive correlation between them. Table

7.12 in the following page gives further summary for the decision reached so far about the hypotheses in this study.

The summary and conclusions of the findings and the research overall are presented in the following chapter.

Table 7.12: Summary of Results of Hypotheses Testing

H#	Research Hypotheses	Accept	Reject
H1	There are significant differences in the learning characteristics between students who understand (knowledgeable) and students who “ <i>don’t understand</i> ” (facing difficulties) construction technology.	✓	
H2(a)	Students with prior experience tend to understand construction technology better than the students without prior experience.	✓	
H2(b)	Students with prior experience tend to show competency in the designing process than the students without prior experience.	✓	
H2(c)	Understanding and competency in construction technology are positively correlated with the prior experience (exposure and experience in architectural knowledge) of the student	✓	
H3	Verbal lecturing (with/without the aid of overhead projector or slides shows) is more popular than teaching which promote experiences (such as with 3D illustrations, using videos and teaching from construction site).	✓	
H4	There is a significant difference in preference on the teaching methods used in teaching construction technology between lecturers and students.	✓	
H5	Understanding of construction technology is positively correlated with the performance in the design process.	✓	
H5(a)	Understanding of construction technology is positively correlated with confidence in design	✓	
H5(b)	Understanding of construction technology is positively correlated with the ability to think on construction and design (theory and practical) concurrently.	✓	
H5(c)	Understanding construction technology is positively correlated with the ability to relate construction method with design.	✓	
H5(d)	Understanding of construction technology is positively correlated with the perception that it is an important factor in design and can be used as a design generator	✓	
H5(e)	Understanding of construction technology is positively correlated with the perception that it is one of the major elements of the whole body of design.	✓	
H5(f)	Understanding of construction technology is positively correlated with superior design result.s	✓	

Chapter 8

Conclusions and Further Research

8.1 Introduction

In this chapter, the researcher aims to summarise the entire study and derive conclusions from the investigations for the purpose of recommending possible solutions to the problems facing students in learning construction technology in relation to design. The research focuses on the relevance and contribution of learning theory to architectural education besides understanding the problems and the pedagogical development at the same time. A summary of the discussion of key findings (from chapter 2 to chapter 7) and recommended solutions will be put forward. Discussion on limitations of the current study will be presented. This is followed by directions for further research.

8.2 Summary of the study

The original motive of this research arose from complaints and dissatisfaction among lecturers on the weaknesses shown among students in designing particularly in integrating construction technology into design in the architectural schools. The theoretical knowledge of construction technology that they learn in the classroom does not seem to be useful during the process of designing. From the viewpoint of the academicians, the distinct separation of architectural design studio from its other supportive design components (in this case construction technology) could be the main reason to put the blame on. Review of the learning literature reveals there could be more to this problem: the nature of the two subjects - design which is perceived as subjective oriented and construction which is presumed as technical or objective oriented, methods of learning by students and methods of delivering or teaching the subjects are all contributing to this problem. Thus, the undertakings of such a task

requires a fair understanding of the issues and problems. We propose two approaches to this study: First the study investigates the problems from the nature of the two subjects that are design and construction technology and second we look into the aspects of effective learning and to counter check it we also look into teaching aspects.

The study began with a detailed discussion of two sets of literature: the evolution on the aspect of architectural practice and its effect on development of architectural education. The review on architectural education starts from the early simple traditional craftsmanship process to a highly specialised methods of architectural training. The progress and the development of architectural education then has undergone several years of evolution and modification due to different constraints and requirements set by the public, environment and technology. With the different requirements and constraints, the architectural training programme began to shift its paradigm from the rich craftsmen builders to the modern and fast buildings by conventional drawings. This marked the segregation between theory and pragmatic aspects of architectural design which is still being questioned and debated on. Whatever the situation is, we are here concerned with the consequences of this segregation and what we can do to improve the situation.

In chapter 2, design was reviewed from at least two ways of thinking: the logical, analytical and rational on one hand and subjective, idiosyncratic and irrational on the other hand. Although the analysis is not comprehensive, and it is difficult to define design, exactly due to its ill-structured and dynamic nature (Lawson, 1990), there are at least three aspects of design which influence the thinking in the designing process discussed in this study. They are: design is described as creative thinking, design as problem solving and design is seen as social communication.

In relating to the aspects of understanding construction technology with design, various methodologies were reviewed. These methodologies and experiments were concerned on trying to narrow down the gap existing between the understanding of construction technology and its application in designing. Based on the understanding on the nature of construction technology, two important aspects of the subject need to be highlight here. They are: **first the subject is factual and technical and second it needs an experienced based learning in order to understand it better.** Of course, the methodologies that involve experience require more than just one method of teaching. This normally involves actual designing and constructing the project. Although this method of learning is described in a lot of

literature as beneficial and effective to learners (please refer to section (2.7), this methodology poses its own constraints, which are in most cases the lack of funding, and time consuming for preparing, managing and its actual construction. The chapter also touches on the aspect of technology development and its contribution in architectural education. The chapter reviews on the use of computer aided learning (CAL) especially in the use of the multimedia in aiding architectural learning and teaching. In this aspect, some of the recent literature on the new approach to learning construction technology particularly on the use of computers are discussed. This is discussed in section 2.8. However, conclusions derived from the literature pointed out that the fundamental issues of learning such as appropriate materials and the basic requirements of learners have yet to be addressed by software makers. An urgent need to identify these **fundamental learning requirements** that can be used as guidelines in preparing this new learning aids is justified

The second investigation looks into contributions on the part of learning theories and their application in architectural learning system. The chapter discusses the aspects of learning from early childhood to a mature human being. Two schools of thought of learning theory; the behavioural and cognitive approaches to learning were discussed in detail. The research in this chapter resulting in five important factors influencing the process of learning. They are: **active (not passive) interaction with the learning environment, individual differences in approaching learning contributes to the different performance in learning; experience play an important role in learning, connecting theories with the real life context and finally communication plays a vital role in learning.**

Based on the literature, the researcher categorises factors that contribute to learning performances into two main categories. They are the **internal learning factors** and the **external learning factors**. The internal learning factors are factors directly affecting the learners, that is, the general learning background of students including their learning behaviour, preferences, objectives of studying, motivation and prior knowledge or experiences. On the other hand, the external learning factors are factors which indirectly affect the learners including teaching methods, the environment, teaching materials and means of communicating the knowledge to learners. These factors are also referred to as environmental learning factors. Using these factors as research framework or guidelines, a field study was conducted in the architectural schools in Malaysia. The aim was to find out learning problems facing the architectural students. The study focused on bridging the gap between understanding construction technology and its application in design.

However, concerning the relationship between construction technology and designing process, it is vital to investigate how these students integrate the theoretical aspects of construction technology into design. The differences in their learning methods, experiences and personal preferences on teaching methods among others affecting the performances of the students. Consequently, each and every one of the internal learning factors and external learning factors (independent variables) are tested against a student's level of understanding construction technology and finally against the design performance (dependent variables). Four main hypotheses consisting of twelve sub-hypotheses are tested for the research.

To collect the necessary information and test the 12 hypotheses, a comprehensive research design is required. Because there was no earlier research on the same topic was identified, we decided to approach the problem in quite an extensive platform. A combination of qualitative and quantitative procedures for survey research are selected for this research because the procedures supplement the methodological weaknesses of each other. (Denzin, 1970). Two sets of questionnaires (for students and lecturers) were carefully designed to measure all the variables involved in the study. The questionnaires were initially piloted before they were distributed to the respondents which were randomly selected from students and lecturers from three main universities in Malaysia. This is discussed in detail in Chapter 5.

Chapter 6 discusses attempts by way of exploratory research towards the typology of learning methods (internal learning factors) and teaching methods (external learning factors) affecting the performance of architectural students. This chapter discusses in detail the interview procedures and most importantly presents the results of the interviews which are used in designing and constructing the second stage of the data collection - the questionnaires. The chapter concludes that there is a wide range of problems related to learning and applying knowledge of construction technology into the design process. The main problem is caused by lack of integration on the theoretical aspect of construction technology and its application in design process. The approach of design itself should be '*as part of a whole*' (Lawson, 1993) rather than as a separate discipline. Findings from the interviews highlighted on the importance of experiences and practical association between construction technology and design. However, the two antecedents (internal learning factors and external learning factors) equally contributes to the performances of students. Thus, the results of the analysis from the interviews are categorised into major and other issues. The *major issues* are concerns that have persistently emerged

during the interviews. These issues are classified as important issues and need to be addressed immediately. The *other issues* are matters or problems concerning the cause and effect of the earlier problems in a way also affecting the performances of students. They are considered as secondary because the problem is global in nature and involves a bigger scope of study. For example, learning culture, time management and so on. These issues are suggested for future research.

Chapter 7 discusses the quantitative data analysis and computation process for this study. Generally, the study employs four methods of analysing the variables and testing the hypotheses. They are the **comparative analysis using the Independent-Samples T-test, comparative analysis using paired T-test, relationship analysis using the correlation test** and finally **ranking**. A more direct computational approach was used earlier to identify the variables such as description of the study variables, the segregation or grouping of students who understand construction technology from those who are facing difficulties in the subject (don't understand). These variables are based on rating by respondents using the seven point Likert-scale rating on overall understanding and competency in construction technology.

The research identifies individual methods of learning of these students (learning characteristic factors) that influence the overall design performance. They are: methods of studying, objectives of studying, designing behaviour, motivation and time management. The test on individual methods of learning aims at distinguishing significant differences in the learning characteristics between students who '*understand*' (knowledgeable) from students who '*don't understand*' (facing difficulties) construction technology. For example, although rote learning is not encouraged in learning construction technology, this method of studying is significantly being practised especially among those who are facing difficulties in trying to understand the subject. Efforts on trying to apply theory of construction into design seems to be in vain. A number of possible reasons that might lead to this findings are discussed. One of the main reasons given was the methods of evaluation used in the school is still following the old system whereby grades are based highly on examination rather than course work. A correlation testing between understanding construction technology and final design result supports the argument.

In highlighting the importance of experience and practical application of construction technology in design, findings from hypotheses testing concerning prior experience in practical application prove to be significant. The results presented have been supported by several other similar researches on the influence of experience or

prior knowledge encountered during problem solving in architectural education (Albrecht, 1988; Achtenhagen, 1995; Avis, 1995; Göker, 1997; Verma, 1997). Students with prior learning experience performed better than their counterparts. Based on this fact, we inferred that having adequate prior knowledge reflects higher ability to visualise and rationalise the workability and feasibility of a building design. Therefore, it provides for better problem solving skills and swiftness in decision making. This interpretation, therefore, affects the overall performance of the students.

Teaching method is another area concerned in this research. The research attempts to investigate the gap between teaching methods preferred by students versus teaching methods commonly carried out by lecturers. The aim is to highlight the gap existing between the students and the lecturers from the aspect of learning/teaching preferences, which may be one of the reasons contributing to the problems. The implication from the hypotheses testing indicated that teaching methods preferred by the students are not frequently carried out by the lecturers. This is also supported by evidence from the interviews with the lecturers. The point to highlight here is an indication of a higher demand on visualisation rather than on verbal means of transferring the information for this kind of learning requirement. It is not to deny the importance of '*good verbal lectures*' as argued by (Kromrey and Purdom, 1995) in his experiment on comparison made by students between lecture, co-operative learning and programme instruction,

“The security of having an '*expert*' available and the opportunity for social interaction seems to be two highly desirable attributes of instruction from these college students' viewpoint”
(Kromrey and Purdom, 1995 : 348)

However, for this kind of learning requirement, good lectures have to be supplemented with practical experiences such as going to the site, participating in the project itself or with some visualisation aids that simulate the practical experiences. The evidence presented through hypotheses testing shows that teaching which simulates experience such as learning from site and teaching with adequate visualisation aid were preferred among these students compared to verbal lectures alone.

Finally the research calls for necessary learning requirements for attaining internal and external learning factors. Although these learning requirements are difficult to pin point but they are clearly shown in the hypotheses testing.

8.3 Main findings and recommendations

In conclusion, findings from the study answer the dissatisfaction and complaints among lecturers on the weaknesses shown by architectural students concerning integrating construction technology into the designing process. The study also elevates important inquiry on our learning and teaching requirements which suggest some changes in the syllabus and the pedagogical setting of the present architectural school. They are:

1. Learning Characteristics

Results from the study highlighted the differences in the individual learning characteristics of the students which contribute a major part to the learning phenomenon of the school. The study identifies learning characteristics of students who understand the theoretical aspects of construction technology and at the same time able to relate them into the designing process. Likewise, the study also recognises the characteristics of those who are not able to see these relationship and fail to understand the theoretical application of construction technology into design. These learning characteristics are considered as the first approach to remedy the problems:

a) Active Learning

Active participants in the act of acquiring knowledge means knowledge is acquired because there is a cognitive need to do so (self motivate). It is found that when students are active learners, more constructive discussions and debates among peers as well as with the lecturers concerned are carried out which could be in the classroom or outside like on site, during studio session and the like. These activities will encourage positive critics, queries and promote self-motivation (Biehler and Snowman, 1993). While discussing and debating certain particular issues or problems on construction matters, it is found that students are able to visualise and understand better the theoretical relationship between construction theory and design.

b) Learning objectives geared towards pragmatic approach

In order to encourage active learning (discussed above), and to prevent students devoting themselves to rote learning which this research found popular among the less performing students, an investigation on the objectives of learning and outline of teaching methods in the present curriculum need to be addressed immediately. It has to aim at making students participate in the process of learning. Thus, project works such as model making, laboratory testing, structural and material demonstration and site visits should be compulsory in the curriculum.

Therefore, the objective of learning this subject has to focus on making students appreciate the theoretical aspects of construction technology as a major element in the designing process. By doing so, construction technology can be treated by students as one of the design generators and thus motivate them to inquire more.

c) Integrating construction technology during designing process

The attitude of students towards construction problems during designing has to be changed. The habit of solving construction problems at the later stage of design or leaving them to the 'experts' should be scraped off. Construction technology is an inseparable aspect of design activity that we call architecture. The student begins to learn that in making decisions about construction details he is, in effect, making *design* decisions that contribute to the quality of his building. This is supported by evidence revealed from the investigation on designing behaviour. In this research most of these students agree on this behaviour even though there is a slight difference found between the two groups tested

Therefore, it is suggested that the scope of construction technology and material that is carried through formal lectures should run parallel with the studio project. The fundamental understanding on the principles of construction, that is the idea of building types and structural/material relationship relative to space, form and function have to be clearly understood in both cases.

d) **Keeping students' motivation**

Agreeing with most of researchers on learning motivation with reference to adult learning like (Knowles, 1970; Brophy, 1983a; Brophy, 1983b; Rogers, 1986; Hetherington, 1995) among others, successful achievement will motivate students to learn more. Consequently, symptoms like unwilling to explore new ideas, lack of interest and passiveness in designing are found within students who have been demotivated because of their lack in understanding the practical application of construction principles in design. This is another finding from the interviews. Therefore, keeping the students' interest is a major task for the teacher. One important aspect that the teachers have to recognise is nothing stimulates the students more than correlating construction technology with the real built building.

The findings reveal the first step in identifying the key issues or causes to the learning problems in architectural education. The study shows the implication of individual learning methods towards the quality or performance of learning in reference to design. **The overall conclusion on this aspect goes to the pragmatic application of construction technology into design and effort should be consciously exerted to co-ordinate or synchronise construction technology courses with design projects.**

The study also suggests the evaluation of students on construction courses should be changed. **Evaluation of students should be based on the ability of students to handle construction issues and problems in the designing process and not from the conventional paper examination format which emphasises on theoretical aspects that somehow will lead the weak students devoting to rote learning.** In other words, paper examination for the subject construction technology should be abolished. By doing this, it will not only change the students' attitude towards learning construction technology but at the same time the notion of integrating the subject with design can be accomplished.

2. Prior experience

This study also points out the importance of prior experience in architectural learning system. These experiences will be able to promote confidence in decision making while designing. The findings indicate that experience in technical detailing

including structural, joints, construction systems and building materials is a vital criteria for the students to understand better. Hence, it will reflect their maturity in decision making during designing. Strategic planning to induce these experiences is greatly needed in the school. Besides, learning the relationship between drawing and building the real thing is exiting(Newman, 1978).

Therefore, hands-on experience is recommended to be part of the training especially for the beginning students (first year students). By having this exercise such as designing and **constructing a real life building** such as a simple single function timber construction of a shelter or pavilion, students will be able to understand and relate these experiences for other designs and types of construction.

3. Gap between learning and teaching

This study also points out the gap between learning and teaching in the present architectural learning system. Results from correlation analysis on methods of teaching construction technology preferred between the learning sector (students) and the teaching sector (lecturers) shows an inverse relationship. This indicates that there is a gap between these two sectors. This learning gap is very important and should be recognised because the implication from this gap is that teaching methods in the present architectural school does not fulfil learning requirements of the students. This explains the dissatisfaction and complaints among lecturers on the poor performance of students described earlier in chapter (1).

The research suggests the need for the school to restructure the pedagogic requirements on teaching methods. Teachers have to be more innovative in choosing the strategic teaching methods for their students. They must make sure that they are not just teaching for the sake of completing the syllabus but more importantly they have to make sure that the information is well understood. More visualization aids such as showing video clips of a certain activity during constructing building, slides and three dimensional illustrations are recommended

It is certain that parts of the learning and teaching requirements have been successfully implemented by some instructors in the past but in its entirety, the model outlined above would clearly be difficult using only traditional teaching methods. The use of computer analysis and simulation approach could be possible. The aim of using computer technology in learning and teaching construction technology is not to

replace the normal lecture/tutor basis but aiding learning of this subject. Students can use the technology to explore and learn the subject at their own time and phase. This will narrow the gap between the fast learner from the slow learner student. The system will not only help the students but it will also help the lecturers with their difficulties of arranging and managing site visits.

To sum up, the results of the hypotheses testing indicate significant relationships between understanding construction technology with performance of the designing process. Performance of designing process includes showing confidence in design, the ability to think about construction and design concurrently, the ability to relate construction method with design, perceive construction not only as the technical part of design but also as a design generator, perceive construction as one of the major elements of the whole body of design and finally producing superior design results. The higher level of understanding construction technology was, the higher the performance of students in design.

8.4 Some criticism of the research

Although the major emphasis of this research has been on the examination of necessary learning requirements (internal factors) in architectural education, it is also concerned with gaining a better understanding of the factors that contribute to teaching requirements (external factors). The development of a conceptual research framework and research methodology is important for any research. Since there is no similar research previously carried out on this issue, the questionnaires have to be constructed based on the exploratory research using interviews. This is interesting as most of the questions used exactly the words used by respondents (students and lecturers) when answering during interviews. We can treat this study as a pioneer especially in the context of Malaysian architectural school.

Perhaps, more private institutions which are now becoming very popular and showing an increase in number, should be included in the research. This will give a better perspective on this issue and perhaps understanding of the problems would be more comprehensive. Nevertheless, with a size sample of 447 students and 32 lecturers, the results presented in this research can be considered to be a reasonable estimation of the size for the correlation found between the independent and the dependent variables.

On the other hand, use of personal interviews to obtain primary data has its limitation. While it provides a more complete view of the issues that emerge, it relatively involves a higher cost and it requires a great deal of time for transcribing the data. Using both qualitative and quantitative methodologies also requires a proper training in terms of administrating the questionnaires, communication skills, techniques for data analysis and interpretation of data.

At the moment, the findings on learning performance are based on answers given from the interviews and questionnaires which are then tested using hypotheses. This could lead to some inconsistency on the answers given. Perhaps in future this could be extended by evaluating the students on the basis of experiments or some pre-tested design projects to check the viability of the answers.

9.5 Some contributions of the research

1. The study recognises individual differences in learning characteristics of architectural students which at present there is no empirical evidence on research on this particular group of students so far. This study is vital for the school in order to understand these students and later use this knowledge for the planning and development of learning aids or support especially in computer aided learning which is becoming very popular in the higher learning institutions in Malaysia. This is also in line with the objective of the country to upgrade the learning/teaching methods in correlation with the expanding needs of the country to prepare Malaysia to become the centre of higher learning in South East Asia by the year 2020 ³³(Government Of Malaysia, 1996a; Government Of Malaysia, 1996b).
2. The study also emphasize the needs for the architectural school particularly the architectural school in Malaysia to review their syllabus especially in the aspects of matching the learning and teaching methods practices in the school.
3. Besides that, the findings also act as a supplement to the information on learning in the higher institution which at the moment lacks such research.

³³ Under the Vision 2020 concept, Malaysia aspires to become a fully developed nation by the year 2020

9.6 Direction for further research

Two important directions for future work are derived from this research:

1. The findings from this research have the most promising area for further work and development into the requirements for computer aided learning (CAL) system which can be supportive of, and enhance the process of learning construction technology. In this specific example, we feel that the use of *multi-media* in aiding learning and teaching seems to be an appropriate preference. (Difficulties in understanding construction technology in relation to design is actually common at all architectural schools as previously discussed - please refer to statement of research problem on page 6). An extension to this is looking at the possibility of connecting this learning system (CAL) into the network (e.g. the internet). With the advantages offered by the internet, the system could be accessed not only by all levels and categories of learners but by the architects and experts too.
2. As an attempt to increase the knowledge on architectural students particularly in Malaysia, more research in students' behaviour in learning should be encouraged. The influence of culture on learning perception particularly among the Asian community which is forwarded in the interview findings shows significant difference when compared to its western counterparts. This finding is beyond expectation. Future direction will be best to research in this area. This could lead us to more concrete findings which might change the whole educational organisation and management set up.

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Appendices

Appendix 1: Designing Of Questionnaires For Students

Section A: Criteria used in the questionnaire to elicit overall construction knowledge of students

Intention	Related Questions
<ul style="list-style-type: none"> Self-evaluation on understanding and competence in construction technology in relation to design. 	<p>Q1: I rate my overall understanding in construction technology as high.</p> <p>Q2: I am confident of my knowledge and capability in design.</p>
<ul style="list-style-type: none"> Integration of construction with design. 	<p>Q3: While designing, I always think about construction technique.</p> <p>Q4: I always consider constructional factors in my design because I understand construction very well and can relate it to any design quite easily.</p>
<ul style="list-style-type: none"> Importance of construction technology 	<p>Q5: I always consider constructional factors important in my design because I believe construction can be a design generator</p> <p>Q6: I always consider constructional factors in my design because I believe construction is as important as other factors in design.</p>

Section B:

Learning methods adopted by students

Intention	Related Questions
<p><u>Methods of Studying:</u> The questions cover learning behaviour/method practiced by the students which include:</p> <ul style="list-style-type: none"> attitudes towards examination, browsing at colourful images, technical inclination, and attitudes towards lecturer/s. 	<p>Q7: I have to concentrate on reading and memorising construction theories, systems and detailing in order to pass the examination.</p> <p>Q8: I find that I have to sketch diagrams on construction detailing repeatedly, in order to be well verse in construction technology.</p> <p>Q9: I always discuss with friends or seniors to better understand construction technology.</p> <p>Q10: I always discuss issues and problems regarding construction with my lecturers and in this way I can understand better.</p> <p>Q11: I can learn construction technology by just listening to delivered lectures.</p> <p>Q12: I can understand construction better by just reading books and magazines.</p>

Learning methods adopted by students(cont.)

Intention	Related Questions
<p><u>Objectives of Studying:</u> The questions cover reading, memorising, discussion, listening to lectures etc.</p>	<p>Q13: Examination is very important to me. I always work hard to pass more than understanding the subject.</p> <p>Q14: I always check my design and its construction detail thoroughly before submitting my drawings</p> <p>Q15: When I learn something I try to see in my mind how all the idea fit together</p> <p>Q16: I generally prefer lecturers/tutors who explain to me what we learn relates to the outside world.</p> <p>Q17 I tend simply to accept what I am told by the teacher without thinking whether I actually agree or not.</p>
<p><u>Designing</u> (Factors or elements emphasised during designing exercises).</p> <p>The questions cover designing process, design emphasis - philosophy, external form and shape, functional aspect, technical aspect like construction, structure, environmental etc. and presentation.</p>	<ul style="list-style-type: none"> • <u>Emphasis on construction technology</u> Q18: I put less effort into construction technology in design project because I can always consult my lecturer/s later. • <u>Designing process</u> Q19: When designing, I always follow the design process in exactly the same sequence. • <u>Design emphasis - philosophy</u> Q20: I concentrate more on the philosophical aspect of design than on the technical or construction aspect. • <u>Design emphasis - technical aspect</u> Q21: When I do my design, I put extra effort in technical aspects(e.g. construction, services, environment, structure etc.) • <u>Design emphasis - presentation</u> Q22: When I do design, I always put more effort into the presentation because it will then be more attractive and thus I can earn more marks. • <u>Design emphasis - external form</u> Q23: When I design a building, I always emphasise its external form and shape. • <u>Design emphasis - functional aspect</u> Q24: When I do my design, I always stress its functional aspect.

Learning methods adopted by students(cont.)

Intention	Related Questions
<p><u>Preferred learning methods:</u></p> <p>The questions intend to find out the various methods or media of learning preferred by the students.</p>	<p>Q25: In order for me to understand construction technology better, I need to look at the actual construction being carried out on site.</p> <p>Q26: I can understand construction lectures better if there are slides showing the building examples used.</p> <p>Q27: I can understand construction better by looking at videos showing how construction is actually carried out.</p> <p>Q28: I can understand construction drawings and diagrams better with the help of 3D illustration.</p> <p>Q29: To understand construction better, I need to see the relationship between its 2D and 3D drawings.</p> <p>Q30: I can understand construction better if I can participate in the construction of the building myself.</p> <p>Q31: I can understand construction from just reading books and magazines.</p>
<p><u>Learning motivation:</u></p> <p>The questions intend to find out the overall motivation of the students towards learning construction technology</p> <p>e.g. if their motivation is low the students will discard their possibly flamboyant design or they would make/find excuses for such behaviour.</p>	<p>Q32: In my opinion construction technology is a very interesting subject.</p> <p>Q33: I always enjoy learning construction technology.</p> <p>Q34: I like to try an adventurous design regardless of construction difficulties.</p> <p>Q35: I will discard a possibly flamboyant design if I can't solve the construction problem.</p> <p>Q36: I prefer simple forms so that I won't face complicated construction problems.</p>
<p><u>Time management</u></p> <p>The questions intend to find out how the students manage their time.</p>	<p>Q37: I work steadily throughout the semester rather than leaving everything to the last minute.</p> <p>Q38: I divide my time equally between all my subjects.</p> <p>Q39: I prefer to fit my assignments or other work into my own personal timetable.</p>

Section C:**Aspects on learning that contribute to bridging construction technology with design**

Intention	Related Questions
(i) To identify students' opinion on learning construction technology from theoretical aspects.	Q40 The difficulties in understanding construction technology result from lectures mainly dealing with theories.
(ii) To identify students' opinion on learning construction technology from its pragmatic aspects (relating construction to outside practice).	Q41: I generally prefer lecturers/tutors who explain to me the relation between learning and the real world.
(iii) <u>Frequently asked questions</u> The questions intend to investigate the area in which students have difficulties in understanding the subject.	<p>Q42: Questions that I normally ask during lecturing session are always concerning application of construction theory into design practice.</p> <p>Q43: I normally ask questions on detailing from my construction lecturers.</p> <p>Q44: I normally ask questions on construction materials from my construction lecturer.</p> <p>Q45: I normally ask lecturer/s to show me examples using pictures, slides or sketch on the board and to show examples on how construction theory relate to other design elements such as services, environmental factors etc.</p>

Section D:**Educational and Biographical Information**

Intention	Related Questions
These questions concerned the respondent's background, that is, his educational background, years of study, gender, and experience (includes entry qualification, training and working experience in construction related field).	<p><u>Question</u></p> <p>a)Institute/s of learning</p> <p>b)Years of Study</p> <p>c) Sex</p> <p>d) Entry qualification</p>

Appendix 2

Questionnaires For Students

February 1997: Questionnaire on Approaches to Learning and Teaching

Construction Technology as Part of Design Process

The application of Information Technology(IT) in Malaysia is vast and rapidly increasing all the time. The increasing use of this technology allows a greater use of computer based applications to enhance and assist learning and teaching in higher education including the domain of architecture. The objective of this research is to use these applications to bridge the gap between students' understanding of constructional technology and their design process.

To achieve this objective, it would be much appreciated if you could kindly participate in this survey by answering the questionnaire as honestly as possible, so that the answers you give will represent an accurate picture of how construction technology is learned and how the problems are faced in the learning process. Only then can this research produce valid conclusions which will help to further extend the application of the modern computer-based method in the learning and teaching of construction technology in an architectural school in Malaysia.

The following sheets contain a series of statements mainly expressed by the staff and students I have interviewed. Please say whether or not you agree with each of the statements. Please use the following scale for all statements.

- 1 = Totally disagree
- 2 = Strongly disagree
- 3 = Slightly disagree
- 4 = Neutral
- 5 = Slightly agree
- 6 = Strongly agree
- 7 = Totally agree

I will treat the information you give in complete confidentiality. I am aware of, and will strictly abide by, the confidentiality of the information. Please be assured that the research findings will be used for academic purposes only.

Finally, may I offer my sincere thanks for your cooperation and time

Yours sincerely,

RODZYAH HAJI MOHD YUNUS
Ph.D Research Student

	Totally disagree	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree	Totally agree
1) I rate my overall understanding in construction technology as high.	1	2	3	4	5	6	7
2) I am confident of my knowledge and capability in design.	1	2	3	4	5	6	7
3) While designing, I always think about construction technique	1	2	3	4	5	6	7
4) I always consider constructional factors in my design because I understand construction very well and can relate it to any design quite easily.	1	2	3	4	5	6	7
5) I always consider constructional factors important in my design because I believe construction can be a design generator	1	2	3	4	5	6	7
6) I always consider constructional factors in my design because I believe construction is as important as other factors in design	1	2	3	4	5	6	7
7) I have to concentrate on reading and memorising construction theories, systems and detailing in order to pass the examination.	1	2	3	4	5	6	7
8) I find that I have to sketch diagrams on construction detailing repeatedly, in order to be well verse in construction technology.	1	2	3	4	5	6	7
9) I always discuss with friends or seniors to better understand construction technology.	1	2	3	4	5	6	7
10) I always discuss issues and problems regarding construction with my lecturers and in this way I can understand better.	1	2	3	4	5	6	7
11) I can learn construction technology by just listening to delivered lectures.	1	2	3	4	5	6	7
12) I can understand construction better by just reading books and magazines.	1	2	3	4	5	6	7
13) Examination is very important to me. I always work hard to pass more than understanding the subject.	1	2	3	4	5	6	7
14) I always check my design and its construction detail thoroughly before submitting my drawings	1	2	3	4	5	6	7
15) When I learn something I try to see in my mind how all the idea fit together	1	2	3	4	5	6	7

	Totally disagree	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree	Totally agree
16) I generally prefer lecturers/tutors who explain to me what we learn relates to the outside world.	1	2	3	4	5	6	7
17) I tend simply to accept what I am told by the teacher without thinking whether I actually agree or not.	1	2	3	4	5	6	7
18) I put less effort into construction technology in design project because I can always consult my lecturer/s later.	1	2	3	4	5	6	7
19) When designing, I always follow the design process in exactly the same sequence.	1	2	3	4	5	6	7
20) I concentrate more on the philosophical aspect of design than on the technical or construction aspect.	1	2	3	4	5	6	7
21) When I do my design, I put extra effort in technical aspects(e.g. construction, services, environment, structure etc.)	1	2	3	4	5	6	7
22) When I do design, I always put more effort into the presentation because it will then be more attractive and thus I can earn more marks.	1	2	3	4	5	6	7
23) When I design a building, I always emphasise its external form and shape.	1	2	3	4	5	6	7
24) When I do my design, I always stress its functional aspect.	1	2	3	4	5	6	7
25) In order for me to understand construction technology better, I need to look at the actual construction being carried out on site..	1	2	3	4	5	6	7
26) I can understand construction lectures better if there are slides showing the building examples used.	1	2	3	4	5	6	7
27) I can understand construction better by looking at videos showing how construction is actually carried out.	1	2	3	4	5	6	7
28) I can understand construction drawings and diagrams better with the help of 3D illustration.	1	2	3	4	5	6	7
29) To understand construction better, I need to see the relationship between its 2D and 3D drawings.	1	2	3	4	5	6	7
30) I can understand construction better if I can participate in the construction of the building myself.	1	2	3	4	5	6	7

	Totally disagree	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree	Totally agree
31) I can understand construction from just reading books and magazines.	1	2	3	4	5	6	7
32) I can understand construction from just reading books and magazines.	1	2	3	4	5	6	7
33) I always enjoy learning construction technology..	1	2	3	4	5	6	7
34) I like to try an adventurous design regardless of construction difficulties.	1	2	3	4	5	6	7
35) I will discard a possibly flamboyant design if I can't solve the construction problem.	1	2	3	4	5	6	7
36) I prefer simple forms so that I won't face complicated construction problems.	1	2	3	4	5	6	7
37) I work steadily throughout the semester rather than leaving everything to the last minute.	1	2	3	4	5	6	7
38) I divide my time equally between all my subjects.	1	2	3	4	5	6	7
39) I prefer to fit my assignments or other work into my own personal timetable.	1	2	3	4	5	6	7
40) The difficulties in understanding construction technology result from lectures mainly dealing with theories.	1	2	3	4	5	6	7
41) I generally prefer lecturers/tutors who explain to me the relation between learning and the real world.	1	2	3	4	5	6	7
42) Questions that I normally ask during lecturing session are always concerning application of construction theory into design practice.	1	2	3	4	5	6	7
43) I normally ask questions on detailing from my construction lecturers.	1	2	3	4	5	6	7
44) I normally ask questions on construction materials from my construction lecturer.	1	2	3	4	5	6	7
45) I normally ask lecturer/s to show me examples using pictures, slides or sketch on the board and to show examples on how construction theory relate to other design elements such as services, environmental factors etc.	1	2	3	4	5	6	7

EDUCATIONAL BACKGROUND

- 1. Name:.....
- 2. University:.....
- 3. Year of Study:.....
- 4. Course:.....
- 5. Faculty:.....

Please tick (✓) the appropriate boxes

- 6 Sex:..... ☐ Male ☐ Female
- 7 Entry qualification: ☐ SPM ☐ STPM ☐ Matriculation
- * ☐ SPM+P ☐ SPM+V ☐ SPM+W
- ☐ Others, please specify:.....

[*Note: SPM+P = SPM with polytechnic qualification
SPM+V = SPM with vocational qualification
SPM+W = SPM with working experience

Finally, if there are any comments you would like to make regarding difficulties you have had, or about other aspects of studying, please use the space below to make them.

***Thank you for your cooperation
Rodzyah Haji Mohd Yunus
Architectural Department
University of Sheffield/Institut Teknologi MARA***

Appendix 3: Designing Of Questionnaires For Lecturers

Section A: Teaching Approaches

Intention	Related Questions
To identify teaching methods frequently used.	<p>Q1: My most frequent method of teaching construction technology is giving lectures.</p> <p>Q2: I always show illustrations on white board/blackboard while lecturing on this subject.</p> <p>Q3: I use the OHP very frequently to illustrate any diagrams on construction and I find it very helpful.</p> <p>Q4: I frequently show videos on construction process/ techniques during construction class.</p> <p>Q5: I frequently use study models such as balsa wood, clay etc. to stimulate students' interest in construction.</p> <p>Q6: I frequently take students to the site to learn construction as they can learn better this way.</p> <p>Q7: I frequently show slides on building construction examples and techniques during construction class.</p>
To identify the teaching methods ideally preferred by the lecturers.	<p>Q8: I believe in teaching construction technology through site learning.</p> <p>Q9: I believe in teaching construction technology through the study model.</p> <p>Q10: I believe in teaching construction technology through slide shows.</p> <p>Q11: I believe in teaching construction technology through showing videos.</p> <p>Q12: I believe in teaching the problems of construction technology through illustrations.</p> <p>Q13: I believe in teaching construction technology through 'hands-on-experience'.</p> <p>Q14: I believe examinations are very important in making students learn construction technology.</p>

Since site learning has frequently been voiced out by students and lecturers as one of the most effective methods of learning construction technology, and since (with great misfortune) unfortunately this method is recognised to have a lot of management problems, it is necessary to identify the reasons why it is so. The table below addresses this problem.

Teaching Approaches(continue)

Intention	Related Questions
To identify reasons for not having site learning.	<p>Q15: I seldom take students for site learning because it is time consuming.</p> <p>Q16: I normally give case studies as assignments so that students can go to the site on their own.</p> <p>Q17: I seldom take students for site learning because of noise, distraction, difficulties etc.</p> <p>Q18: I seldom take students for site learning because it requires too many safety procedures and it is sometimes difficult to get permission.</p> <p>Q19: I seldom take students for site learning because there are not many appropriate sites near the university to visit.</p>

Section B: Teaching Concept

Intention	Related Questions
To identify the overall perception towards effective teaching methods of construction technology.	<p>Q20: I believe examinations are very important in making students learn construction technology.</p> <p>Q21: I believe giving the students the principles of construction technology will be more effective than giving them detailed drawings.</p> <p>Q22: I believe in giving the students detailed drawings as it will make them understand construction better.</p> <p>Q23: I don't teach students detailing in class. I believe to give it as homework.</p>

Section C:
Problems And Difficulties Of Learning(from lecturer's view)

Intention	Related Questions
To identify difficulty in understanding construction technology from the teachers' point of view.	<p>Q24: I can see that my students are facing difficulties in understanding construction technology because they exposure to real construction practice.</p> <p>Q25: The students seems to have problems in understanding graphic communication such as building symbols and line drawings, thus they have difficulties in visualising 2D constructional drawings.</p> <p>Q26: There seems be compartmentalisation of knowledge between construction and other related architectural subjects.</p> <p>Q27: I noticed that students ask questions based on their design problems.</p>

Section D:
Influence Of Experience On Student's Performance

Intention	Related Questions
The questions intend to investigate the influence of experience in general over the performance of the students	<p>Q28: I notice students with working experience in the architectural field excel in construction class.</p> <p>Q29: I notice students with polytechnic/technical backgrounds excel in construction class.</p> <p>Q30: I notice students with no experience of construction excel in this class</p>

	Totally disagree	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree	Totally agree
1) My most frequent method of teaching construction technology is giving lectures.	1	2	3	4	5	6	7
2) I always show illustrations on white board/blackboard while lecturing on this subject.	1	2	3	4	5	6	7
3) I use the OHP very frequently to illustrate any diagrams on construction and I find it very helpful.	1	2	3	4	5	6	7
4) I frequently show videos on construction process/techniques during construction class.	1	2	3	4	5	6	7
5) I frequently use study models such as balsa wood, clay etc. to stimulate students' interest in construction.	1	2	3	4	5	6	7
6) I frequently take students to the site to learn construction as they can learn better this way.	1	2	3	4	5	6	7
7) I frequently show slides on building construction examples and techniques during construction class.	1	2	3	4	5	6	7
8) I believe in teaching construction technology through site learning.	1	2	3	4	5	6	7
9) I believe in teaching construction technology through the study model.	1	2	3	4	5	6	7
10) I believe in teaching construction technology through slide shows.	1	2	3	4	5	6	7
11) I believe in teaching construction technology through showing videos.	1	2	3	4	5	6	7
12) I believe in teaching the problems of construction technology through illustrations.	1	2	3	4	5	6	7
13) I believe in teaching construction technology through 'hands-on-experience'.	1	2	3	4	5	6	7
14) I believe examinations are very important in making students learn construction technology.	1	2	3	4	5	6	7
15) I seldom take students for site learning because it is time consuming.	1	2	3	4	5	6	7
16) I normally give case studies as assignments so that students can go to the site on their own.	1	2	3	4	5	6	7

	Totally disagree	Strongly disagree	Slightly disagree	Neutral	Slightly agree	Strongly agree	Totally agree
17) I seldom take students for site learning because of noise, distraction, difficulties etc.	1	2	3	4	5	6	7
18) I seldom take students for site learning because it requires too many safety procedures and it is sometimes difficult to get permission.	1	2	3	4	5	6	7
19) I seldom take students for site learning because there are not many appropriate sites near the university to visit.	1	2	3	4	5	6	7
20) I believe examinations are very important in making students learn construction technology.	1	2	3	4	5	6	7
21) I believe giving the students the principles of construction technology will be more effective than giving them detailed drawings.	1	2	3	4	5	6	7
22) I believe in giving the students detailed drawings as it will make them understand construction better.	1	2	3	4	5	6	7
23) I don't teach students detailing in class. I believe to give it as homework.	1	2	3	4	5	6	7
24) I can see that my students are facing difficulties in understanding construction technology because they exposure to real construction practice	1	2	3	4	5	6	7
25) The students seems to have problems in understanding graphic communication such as building symbols and line drawings, thus they have difficulties in visualising 2D constructional drawings.	1	2	3	4	5	6	7
26) There seems be compartmentalisation of knowledge between construction and other related architectural subjects.	1	2	3	4	5	6	7
27) I noticed that students ask questions based on their design problems.	1	2	3	4	5	6	7
28) I notice students with working experience in the architectural field excel in construction class.	1	2	3	4	5	6	7
29) I notice students with polytechnic/technical backgrounds excel in construction class.	1	2	3	4	5	6	7
30) I notice students with no experience of construction excel in this class	1	2	3	4	5	6	7

Finally, if there are any comments you would like to make regarding difficulties you have had, or about any aspects of teaching construction technology, please use the space below to make them.

***Thank you for your cooperation
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Appendix 5: Interview Schedule (Student)

GROUP INTERVIEW SCHEDULE
(Student)

NAMES:M/FM/FM/FM/FM/FM/F	AGE..... AGE..... AGE..... AGE..... AGE..... AGE.....	Interview No: Group No:
YEAR OF STUDY:		Tape No:
COUSE/FACULTY:		Date:
UNIVERSITY:		Time:
INTERVIEWER'S INSTRUCTION		

In the opening stage of the interviewing process, the interviewees will be informed about the purpose of the research and their role as interviewees. The sequence of questions will be kept flexible to avoid repetitive questions over points raised previously by the interviewees. To obtain objectivity and accuracy of response, interruption from the interviewer will be kept to a strict minimum where the interviewees will be encouraged to talk freely on the subject. The interviewer will refrain from any arguments which might lead to conflict of ideas and ideological perspective. However, the interviewees will be assured that all information will be kept confidential.

1.Background	Notes:
1. a) Briefly describe your family background. Do any of your family were in this profession? Do your family encourage/ influence you to be in this course? How do you feel about the course?	
1.b)When do you join the university? What were your qualification? Why do you choose the course?	

1. Background	Notes:
<p>1.c) Which high school did you come from before enrolling in the university?</p> <p>Do you feel your previous school has contributed some weight to your study? In what way?</p> <p>Do you have any working experience before joining the course?</p> <p>Do you feel your job experience has contributed some weight to your study? In what way?</p>	
<p>2. a) Think of the time when you first joined the architectural school.</p> <p>What is your opinion about architecture then? Are you always interested on architecture?</p> <p>Which subject/subjects are you good at and why?</p> <p>Which subject/subjects are you lacking at and why?</p>	
<p>2. b) What do you think about building construction?</p> <p>Do you like the subject? Do you have any difficulties in understanding the subject?</p> <p>Can you elaborate more on the difficulties.</p>	

2. Problem Identification - Construction	Notes:
<p>2. c) Do you ask your lecturer if you do not understand the lecture given? What specific area do you normally ask him/her?</p> <p><i>probes:</i> application of construction, understanding on the system, example used, detailing, materials used.</p>	
<p>2. d) How do you study Building Construction?</p> <p><i>probes:</i> reading & memorising, drawings, discussion with friends, lecturers, site visit asking lecturers.</p>	
<p>e) Which learning approaches can you think of, suit you to learn Building construction? Why?</p>	
<p>2. f) Can you try to remember as much as you can about what you have learned about Building Construction lecture during this session.</p> <p>Please write it out as though you are going to teach someone just like yourself, with the same level of knowledge as you had before you started. Be as detailed as you can.</p>	
<p>g) Do you think you understand all the construction lectures delivered in the classroom? Please elaborate.</p>	
<p>h) If you are given the responsibility to teach construction technology to the first year architectural student, how would you teach them?</p> <p>In your opinion which is the best method to teach construction technology?</p>	

3. Problem Identification - Design	Notes:
<p>3, a) How do you solve your design problems? (How do you do your design?).</p> <p>Please describe your steps for example to design a simple building?</p> <p><u>probes:</u> design process- inception, analysis, synthesis, sketches, models etc</p>	
<p>3. b) Do you have difficulties doing your design project? Please elaborate.</p> <p>Why do you think they are a problem to you?</p>	
<p>3. c) When you are actually designing the building, what factor do you consider to be the most important? Why?</p> <p><u>probes:</u> form, space, construction, structure, building services, thermal comfort.</p>	
<p>3. d) How important in your opinion construction knowledge in design? Why?</p> <p>Do you think construction knowledge can be an important factor to generate creative ideas in design? Please elaborate.</p>	

3. Problem Identification - Design	Notes:
<p>3 e) Do you have any problems applying construction knowledge in design?</p> <p>If yes, why do you think it is a problem?</p> <p>What do you suggest to solve or improve them?</p>	
<p>3. f) While doing your design project, are you adventurous enough to try new forms regardless of technical matters?</p> <p>When you have done that, do you try to solve the construction problems yourself at that time or leaving it to be solved later by the help of the lecturer or leaving it to the specialist (e.g. the engineers)</p>	

4 learning motivation	Notes:
<p>4. a) Do you find the subject Building Construction interesting? Why?</p> <p>Do you normally participate in the class discussion?</p>	
<p>4. b) What other methods used by you in order to understand the subject better (beside attending the scheduled lectures)?</p> <p><u>probes:</u></p> <p>actually looking at real building construction on site, looking at manufacturer's catalogues, doing some construction model, sketches.</p>	

4 learning motivation	Notes:
<p>4. c) Do you discuss the subject with your friends?</p> <p>How often?</p>	
<p>4. d) How do you manage your time, in reference to doing design projects and learning other lectures subject?</p>	

5 Feedback	Notes:
<p>5. a) Do you receive adequate feedback (from the lecturers) on your work?</p> <p>Please elaborate. Are the feedback encouraging or threatening?</p> <p>How do you respond to the critics/feedback given?</p>	
<p>5. b) During the crit session, what do you gather from the jurors?</p> <p>Which area do you think you are good at and lacking at? Give reasons.</p>	
<p>5. c) How would you describe your competence on Building Construction?</p>	

ALL REPLIES WILL BE TREATED IN STRICTEST CONFIDENCE

Thank you for your cooperation

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Appendix 6: Interview Schedule (Lecturer)

INTERVIEW SCHEDULE
(Lecturer)

NAME:	M/F	Interview No:
DEPARTMENT:		Tape No:
SUBJECT TAUGHT:		Date:
UNIVERSITY:		Time:
INTERVIEWER'S INSTRUCTION		

In the opening stage of the interviewing process, the interviewees will be informed about the purpose of the research and their role as interviewees. The sequence of questions will be kept flexible to avoid repetitive questions over points raised previously by the interviewees. To obtain objectivity and accuracy of response, interruption from the interviewer will be kept to a strict minimum where the interviewees will be encouraged to talk freely on the subject. The interviewer will refrain from any arguments which might lead to conflict of ideas and ideological perspective. However, the interviewees will be assured that all information will be kept confidential.

1. Background (experience)	Notes:
1. How long have you been working in the university? Do you have any working experience before joining the university? Where? Do you think this experience help you in your teaching? In what way?	

2. Ideology (set of principles)	Notes:
<p>2. We believe that each individual has his/her own set of principles(ideology), can you please list them according to priority. Do you follow this ideology when teaching</p> <p><u>probes:</u></p> <p>form follow function, idea, context, order, quality, true expression of the materials, honesty in building etc.</p>	
3. Methodology	
<p>3. Please describe your specific method of teaching when dealing with design and when teaching Building Construction? Please describe from the introduction of the program to the evaluation of student.</p>	

4. Problem Identification - Construction	Notes:
<p>4 a) Did your students ask questions during lecture time? How often do they ask? What specific area do they normally ask? How do you reacted towards these questions?</p> <p><u>probes:</u> application of construction, understanding on the system, example used, detailing, materials used</p>	
<p>4. b) Do you see any problems faced by the students in understanding construction in relation to design project? Can you identify the problems? What is your suggestions to help solving these problems?</p>	

5. Students' Motivation	Notes:
<p>5 Do you think the students enjoy learning Building Construction? Why? In your opinion, what is the commitment of the students towards the subject?</p>	
6. Students' Competence	
<p>6. How would you describe their competence on this subject?</p>	

7. Suggestions	Notes:
<p>7. What are the other means of teaching Building Construction do you suggest to improve the teaching methods currently practiced in this institution?</p>	

ALL REPLIES WILL BE TREATED IN STRICTEST CONFIDENCE
Thank you for your cooperation

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Appendix 7

Detailed Analysis Of Interview With Students

The General Findings (Summary of the finding was illustrated in diagram below)
The major questions these interviews seek to answer can be categorised as follows:

- Educational background of the students.
- Understanding of construction technology- problem identification
- Understanding construction design link - problem identification
- Learning styles practiced by the students
- Nature of consultation and feedback received by students
- The overall competency

The followings are the issues extracted from the interviews:

Educational Background Of The Students Prior Entering The University

Questions:

- Briefly describe your educational background?
- When do you join the university? What was your qualification to enter the university?
- How do you feel about the course?

Answers:

"age 24, (male)

Join the university (UTM) in 1990 using SPM qualification to enter university

No working experience only from the practical training

I received encouragement to join architecture from sisters who are a quantity surveyor and engineer

I found architecture is fun course, because there is an exploring of ideas in architecture. It is also a very socialize profession"

"Age 25 (female)

Enter ITM using Polytechnic qualification in 1993.

I am very much interested in architecture

In my opinion architecture is an interesting course as it is always developing or creating new ideas and things

I learn the basic principle of construction in polytechnic and found it useful to further enrich the knowledge while learning in ITM

Not much design is learn in polytechnic - the syllabus is more towards construction and drafting of simple buildings"

"Age 25 (male)

Join the university in 1992 using Diploma qualification from polytechnic and an additional two years working experience in construction industry as a site supervisor.

To me the course is interesting and manageable...yes I understand how building works and can imagine so. I have no problems on construction in fact, students always refer to me (constantly)when they have problems in construction especially in design"

Age 22 (male)

Enter USM in 1992 using the STPM(Sc. stream) qualification.

To me the course is tough one and I always have problem in understanding construction. The previous educational knowledge in form six does not contribute any weight in my study because the subject is totally different and no relationship with the cause now. The problem I am facing now is that I cannot visualize the architectural drawings especially section of building"

Summary:

- The educational and technical experience of the students contributes to better understanding of construction technology.
- This was indicated in the interview sessions that students with the appropriate background was able to reflect and relate impressively with matter concerning construction in the interview sessions.

Understanding Construction Technology - Problem Identification

Questions:

- What do you think about the subject building construction? Do you like the subject?
- Do you have any difficulties in understanding the subject? Can you elaborate on the your difficulties?

Answers:

"I only understand about 10% - 20 % of the construction lectures given to me. I have difficulties in understanding construction technology and I sometimes I have to copy construction drawing from magazines and books in order to submit my design project".

"At the moment we are still using the conventional methods of construction...There is no encouragement to explore into new technology

Summary:

- Understanding construction technology is highly influenced by the students' understanding in the following domain:
 - i) Building construction and material,
 - ii) Design process.
 - iii) Graphic communication.(understanding on building symbols and graphics)

Understanding Construction-Design Relationship - Problem Identification

Questions:

- How do you solve your design problem? Do you have difficulties doing your design project. Please elaborate.
- When you are designing a building, what factor/factors you consider to be most important? Why?

- How important construction knowledge in design?
- Do you think construction knowledge can be an important factor to generate creative ideas in design?
- Do you have problems applying construction knowledge in design? If yes, why do you think it is a problem to you?
- What do you suggest to solve or improve them?

Answers:

"I have problems in understanding construction especially when it comes to the transformation of ideas into the building forms. I think I need to really understand the relationship between 2D and 3D drawings"

"If I cannot solve the construction problems then I will discard the design no matter how beautiful they are and try new design which is simpler"

"I limit, I stop design because of construction..."

"...the problem is when it comes to the transformation of ideas into the building forms ...normally this is the critical parts and always being rejected by lecturers with reasons such as contradicts with the building laws, planning laws not practical etc..."

Summary:

- Students must be able to integrate construction technique in design.
- The students must be able to comprehend the linkage between construction and design in order to understand the function of construction in design. This is being affected by the way each process of designing is carried out, which are either in *linear* or *cyclic* process.

Learning Styles Practiced By The Students

Questions:

- How do you study building construction?
- Do you think you understand all the construction lectures delivered in the class room? Please elaborate.
- Do you ask your lecturer/lecturers if you do not understand the lecture given? What specific area do you normally ask him/her?
- Which teaching approach you think suit you to learn building construction?

Answers:

"I face the difficulties in construction especially in the early years of architectural course".

"I normally refer to the experienced students usually the ex-polytechnics when come to construction problems"

"It is interesting to learn construction but I have difficulties when come to solving construction problems in my design".

"Because of time constraints, I used to copy buildings or construction detailing from magazines or books without understanding it for my construction drawings"

"I will discard an idea if I think I cannot solve the construction problems"

"Due to limited time and we have to do a lot of presentation drawings, I will normally do simple design "

"when we go to the construction site we can experience the construction from all aspects. We can learn its system, the jointing, detailing and materials used"

"I prefer to learn from real life construction or building, understand it and draw it back yourself"

"I feel site visit is very necessary in learning construction"

"I don't really understand construction lectures given in the classroom, even though sometimes slides were shown but showing pictures is very superficial, we need look at actual construction being carried out on the site"

"I never forget when we do the wakaf (in Bahasa Malaysia which means pavilion) project last year. It was fun and I felt the experience constructing it helps me a lot in understanding basic construction."

"I have no formal training or working experience in construction before but I feel the experience I had on construction "wakaf"(in Bahasa Malaysia which means pavilion)last year really make me understand construction especially in timber"

"I need some kind of fun(play structure) in the learning of construction... may be we can have some structure models on the school site."

"I would suggest to have two sets of study models... one set is for the students and the other for lecturer to see. We then can work together to create new design out of some simple construction system"

Preferred media used during learning

"I think , I would prefer to learn construction theory and alternately with videos shows. There are slides shows presented by the lecturers to us but in my opinion it is not as good as videos because slides is still two dimensional presentation and we won't be able to understand it as videos does"

"I prefer a three dimensional illustration as I can visualize the whole construction process"

"If we can get models of construction on the school site , it will be much better to understand construction"

"I would prefer video show second to site learning"

"If we can have something like animation (computer) this will be very interesting for us to learn and also it can show the process or step-by-step assembling of building elements"

"Besides site learning, I would prefer to learn construction from study models"

"I am not happy with the way we are taught here. I can't get the essence of learning construction... may be lack of visual contact as I learn better(faster) through visual especially 3D like videos or slides (but i prefer video better than slides as slides is stiff and still using two dimensional illustration...and materials like animation....."

Learning practices

"I usually look at sketches and drawings from books or magazines and discuss them with friends usually those from the Polytechnics"

"I prefer to learn from site. That is having the lecturer explaining the construction on the site"

"I used to go to the site on my own in order to understand construction because I can understand and then remember better from practical rather than giving me theory"

"I learnt by heart or memorize theories about construction. I even memorize the diagrams and dimensions through repeat sketching, but I think I don't understand the reasons for that construction such as why certain construction member has to be bigger or smaller than the other etc. I only learnt them for examination"

"I used to Photostat detailing but found it not effective"

"Refer to hand out given by the lecturers and discuss with friends"

Motivation of the students towards learning.

"Only in semester 7 students are exposed to steel construction. This is very new and exciting to us. Due to this we will try to explore on innovative design in terms of its building forms and almost everybody in our class experiment on steel construction on their design - mostly on space frame"

"It will be a boring subject if there is no variation in terms of the materials and construction techniques"

"Yes we do ask the lecturers but that depend on the lecturer himself or herself. If he/she is good at the subject and encouraging us then we ask, if not we just sit and listen"

Summary:

- The learning method adopted by the students influenced the overall performance and effectiveness of learning construction technology. From the interview, there are four identified factors that influence learning approaches:
 - i) learning media
 - ii) learning practices
 - iii) learning preferences
 - iv) motivation.

Nature Of Consultation And Feedback Received By Students

Questions:

- Do you do any discussion on the subject? How often and with whom do you normally discuss with?
- Do you receive adequate feedback (from the lecturers or other professional persons) regarding construction technology? Are the feedback encouraging or threatening?

Answers:

"I think we are lacking in feedback especially from the outside professionals"

"When we argue with lecturers, we have to do it with some restrictions because sometimes they will marked on you and then you find that you would not have much support from them."

"Information from lecturers are sometimes not very clear"

"Feedback that we received from the lecturers are normally in the aver all manner not individual...I do not ask the lecturers if I am not satisfied with the marks given to me, because I am afraid that the lecturer might marked me"

"We have difficulties in references. The library is lacking in videos and good international magazines. We have videos on construction but it is already outdated."

"We have problems in the languages as most books are in English. Those books written or translated in Bahasa Malaysia are sometimes giving us problems in the aspect of terminology used. They are not standardized. Besides that when we refer to the international magazines, we have difficulties in understanding them as the example used are not from local buildings thus, it is difficult for us to relate to"

Summary:

- Good feedback and adequate references (books, magazines ,videos, slides and etc) is vital to the understanding of construction technology.
- Feedback provided by lecturers, professionals and peers tend to show positive effects towards understanding of construction technology but this was not a frequent affair.
- Students tend to carry out discussion among peers. The weaker students seek help from seniors or from friends with some technical or experiences in the construction area.
- An informal discussion tend to be favored and they normally carry out in the studio.
- Students also faced problems on lack of updated resources like new journals, understanding the information from the journal; as the examples used are not from local buildings, and they faced difficulties in the understanding of technical technology translated in the national language the *Bahasa Malaysia*.

The Overall Competency

Questions:

- If you were give a task to design and build a double story house, would you be able to do so? OR Can you explain how to build a timber pavilion?
- How would you describe your competency on construction technology?

Answers:

"I am not very sure. I need some guidance from friends or lecturer then I will be confident to build the building"

"I have no confident at this moment. May be after few years of working experience then I think I can honestly say that"

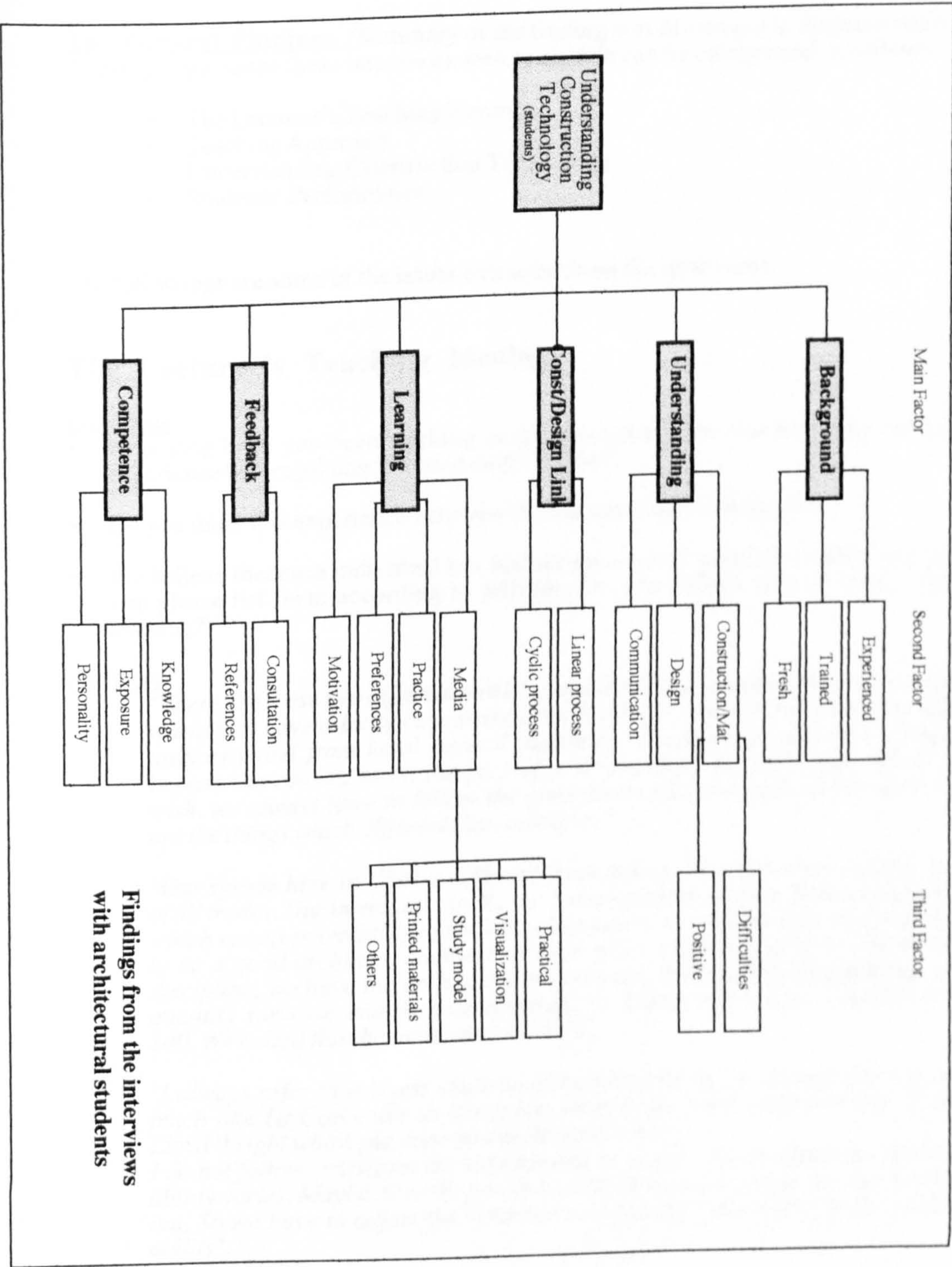
"To me I am confident enough that I can handle at least two story building or four story simple flats. I say this because I have experience doing it and in fact I have done quite a few of that sort"

"I quite confident with a simple timber building like a pavilion because of the experience I had during the construction project we had last semester, which is the construction of the 'wakaf' organized by university"

"I am quite competence with small simple conventional building like simple bungalow etc but I am not confidence at all with complicated high tech building construction"

Summary:

- The overall competency of the students towards designing and building is not very convincing to the researcher yet. It is clearly affected by:
 - i) the construction knowledge of the student
 - ii) the exposure of student to construction technology
 - iii) the individual personality of student.



Appendix 8

Detailed Analysis Of The Interview With Lecturers

The General Findings (Summary of the finding was illustrated in diagram below)
The major questions these interviews seek to answer can be categorised as follows:

- The Lecturer's Teaching ideology
- Teaching Approach
- Understanding Construction Technology
- Students' Performance

The followings are some of the issues extracted from the interviews:

The Lecturer's Teaching ideology

Questions:

- How long have you been working in the university? Do you have any working experience before joining the university? Where?
- Do you think this experience help you in your teaching? In what way?
- We believe that each individual has his/her own set of principles(ideology), can you please list them according to priority. Do you follow this ideology when teaching?

Answers:

"There are these two different world of academic and practical world. Practical world you have a lot of constraint from 3 sectors: the federal authority, state authority and from local council authority. These three authorities always impose the constraint on the part of your practice. We cannot do what we wish, we always have to follow the guidelines, bye laws and all the acts, this are the things which different than academic".

"Our system here in USM is different from others. We called this system jack of all trades. Our intention is to dig out bakat (translated from Bahasa Malaysia which means potentiality of students) because not everyone have the potential to be a good architect, engineer or even other related professionals. In this discipline, we have the architects, the planner, the building engineering, the quantity surveyor and the management. So, that is why I have students over 140. We called this the integrated studio".

"I always refer or address students of building being functional, but not too much like Le Corbusier as being too straight forward but more like Frank Lloyd Wright which put taste into architecture with I do not follow strictly on the step-by-step of design process because students ability varies. Maybe 30 to 40 percent can follow the schedule but the rest are not. So we have to adjust the schedule accordingly- according to the student ability".

Summary:

- The professional and teaching experiences of the lecturers tends to influence the understanding of construction technology.

- Students tend to understand better if the lecturer has good teaching and professional experience.
- There was a clear indication that the students tend to be able to relate and reflect better with lecturers of these background.

Teaching Approach

Questions:

- Please describe your specific method of teaching construction technology? Please describe from the introduction of the program to the evaluation of the student?
- Do you think this method of teaching is good enough?
- What are the difficulties and problems in carrying out this program?
- Please describe your specific method of teaching/tutoring design in the studio? Please describe from the introduction of the design program to the evaluation of the student?
- Do you think this method of teaching is good enough?
- What are the difficulties and problems in carrying out this program?
- What are the other means of teaching Building Construction do you suggest to improve the teaching methods currently practiced in this institution?

Answers:

"Our government is trying to expose the technology into the country. We rely heavily on international expertise so we are losing a lot of money to the foreign skilled workers e.g. Batu Tiga Stadium (Hijjas Kasturi), the engineers are from Germany and the contractors are from Hungary, KLCC, KLIA and all these projects involved foreign industries, foreign contractors and foreign designers like KLCC the architect is Cesar Pelli the contractors are from Japan and Korea, Telikom Tower the architect is Kumpulan Senireka and the contractors are from Korea, KLIA (K.L international Airport) in Sepang by Koshu Kurokawa....."

"From these examples we can use them by exposing the students to the construction site in terms of case study to these buildings. This will really expose students to the problems and construction techniques. Such as in Batu Tiga Stadium it shows how they erect the structure which is without columns. But of course, to have site visits to all these buildings is time consuming"

"In teaching construction, I believe that 'seeing is understanding.' Without seeing the real thing, it is very difficult for someone to actually understand it. 'Seeing is also knowing'. That is why in my class I always insist on them to see the real construction themselves."

"I always choose the building where they can see the structure of the building. The problems on projects which is still under construction is that sometimes it is difficult to get one we will normally end in the finished project. This is a disadvantage as the students won't be able to see all the construction process."

" There are problems regarding site visit, such as there are hustles and difficulties in explaining to these forty to fifty students at the site and also controlling them through the site"

" On teaching steel construction, normally we just give them the theoretical parts. We don't bring them to the site.....

It is always taking the students to the site. Seeing is believing. It is difficult to bring students all the time to the site, so, HBP(Housing, Building and Planning) consultant is having a firm of our own. So by having our own projects it is easier for lecturers to bring students to site and also it will be a training ground for the young and the inexperienced lecturers....This is one of the way I think to improve the learning on construction technology"

"This is something which I failed to do ... go to the site. I must admit it because of time. To me this is the best (with emphasis) way to teach. You go to the site, you actually see those things on site, touch it, feel it, and that is the best way to teach it."

The workshop, where there is exercise construction of simple building like timber or simple concrete... I believe that first hand experience is very effective...."

This semester, they are very good with model making, they enjoy doing model. You can see in their design when they do model they really do good models.

In addition to that I think for this semester, the students are also very committed to their work. For this batch they are very hard working and their team work is very good"

"Design and build it. It can be a simple building, and they do probably a miniature but real. But so far we don't do it"

"I don't think it is necessary, because we are not going to be a carpenters, that workshop is only for you to know timber joinery, bricks layering, we don't have to have the workshop for that, we can just have the models for bricks ...that is good enough or you just pick up bricks and show the works that's all.

What is more important to me on the understanding of construction is to stress on structure. How structure is related to construction.

It has to go hand-on-hand. for example you want to test a roof structure, lab is much more better than the workshop. The structure testing lab will be more beneficial than the workshop where the student can appreciate beam and support, understand the function of beam, and can see such as a roof structure, a king post and test it in the lab."

"I always go to the basic. They have to visualize construction then only they can understand it. How do I make them understand. We have to give them basic understanding right from footing, to the roof. To make them understand two things that I do: first the system structure. For system structure there are three types :

- 1) the post and beam
- 2) is the load bearing and
- 3) is 1 plus 2.

Any building you look around they apply these basic system structure of construction. Secondly, I will ask them to go to the site (on their own time)

take photograph or sketch and show me whether they really understand which refer to the system taught. Sometime they had difficulty to visualize so I asked them to make model for example the staircase or the roof truss. I always have lectures and with sketch as the worked book (individual work)"

"Normally as there are lacking in buildings built with modern construction, the lecturers just give them the theoretical parts. We don't bring them to the site."

"You see it is always good taking the students to the site. 'Seeing is believing', but it is difficult to bring students all the time to the site. So, we hope to create our own HBP consultation firm. By doing so it is easier for lecturers to bring students to site and also it will be a training ground for the young and the inexperienced lecturers. This is one of the way I think to improve the learning on construction technology."

"I notice they like to do models, they like to do for example doing the model trusses etc. They like to play building elements. It is just like a doctor who play with skeleton. We play with building elements or structure. In Materials we have timber, concrete and steel"

"I believe that teaching the students the principle will be more effective than giving them detail drawings e.g. the principle of opening this is the things to know...So in order to understand the detail you ask them to do work. For lecturing I normally use slides, overhead projector and videos but I don't use it anymore now because most of them are outdated and very much referring to the UK situation..."

Summary:

- It is agreed by all the lectures interviewed, that site learning is a very effective method of communicating construction knowledge to students. However this method is not without obstacle. In fact two of the lecturer admitted that they never had site learning with the students as they found it time consuming, difficult to explain on site because it is noisy, problems with safety regulations and difficult to get appropriate site.
- Learning through experience is also highly look upon by the lecturers as one of the best method to teach construction.
- In addition to that lecturers also agreed that if they can provide an additional aid like a 3-D visualization such as videos on the new construction techniques, it will helpful to the students.
- In this section, the researcher felt that teaching media is a very important factor that need to be carefully look at to solve the problem of understanding construction technology. The lecturers believe that once the principle of construction is fully understood by the students then it will be easier for them to use the knowledge in various design.

Understanding Construction Technology

Questions:

- Did your students ask questions in the lecture time? How often do they ask? What specific area do they normally ask? How do you reacted towards these questions?

- Do you see any problems faced by the students in understanding construction in relation to design project? Can you identify the problems? What is your suggestions to help solving these problems?

Answers:

"If we teach them theory alone they will be bored and sleepy..."

"Generally, students will ask questions that relate to their design project. I do have students who has worked before joining UTM and these students are very clever...., Those students posed questions very muchwhich are sometimes beyond what we have told them....because of their experience. But other students normally they just sit and listen"

"Yes, our students have problems in understanding construction technology. Even we try so many ways in teaching them but I am still facing difficulties to ensure that they understand. Sometimes we are not sure whether they understand or not(show some uncertainty and wanting to know/or regret with the situation) The problem is because the practical part as far as architecture is concern, the time is very little for doing the real thing. What we need them to understand is to understand construction while doing design, so I believe that construction subject should be part of our design subject. I hold much believe in that. It shouldn't be separated construction you teach them the theory and then design is another thing. Of course we can teach them construction theory, but it must be parallel with the design exercise, so that they can apply the knowledge on construction in the design within that time."

"Yes very often they ask questions. It seems that they have problems in understand two dimensional illustrations normally, I have to sketch 3D drawing. They need 3 dimensional drawings to understand better. That's why it is important to have the model. I normally have the sketches ready unless when the questions asked then I will show them the 3-D sketches there and then. Yes... 3-D illustration is very important. From the 3D drawings they will understand how construction works."

"It is good if we can have 3D animation. But using computer in teaching computer is at risk due to electricity. When the power is down the computer cannot be done and then we are back again to basic pen drawing. If computer can relate to manufacturer's information on materials, this is very good. It will be easier for students to look into specification of building materials available in the market. This will be a help to the student."

Summary:

- Lecturers tend to believe that construction theory must be taught in parallel with the design exercise, so that students can apply the knowledge of construction in their design within that time.
- There are lacking in the teaching of construction technology which includes 3-D illustration such as videos and updated references (local and international)

Students' Performance

Questions:

- Do you think the students enjoy learning Building Construction? Why?
- In your opinion, what is the commitment of the students towards the subject?

- How would you describe their competence on this subject?

Answers:

"I would say only 50 percent of the students enjoy learning construction because I think they are over burden with other works, therefore they cannot be committed. To be frank, I don't know where is the problem. I only know this is not a popular subject."

"Students learn construction for the sake of passing. I cannot judge their competence from the examination, I can only judge their competence through comments from other lecturers, I received complaints from design lecturers regarding this matter. I think students may understand the principle but they have problems in its application."

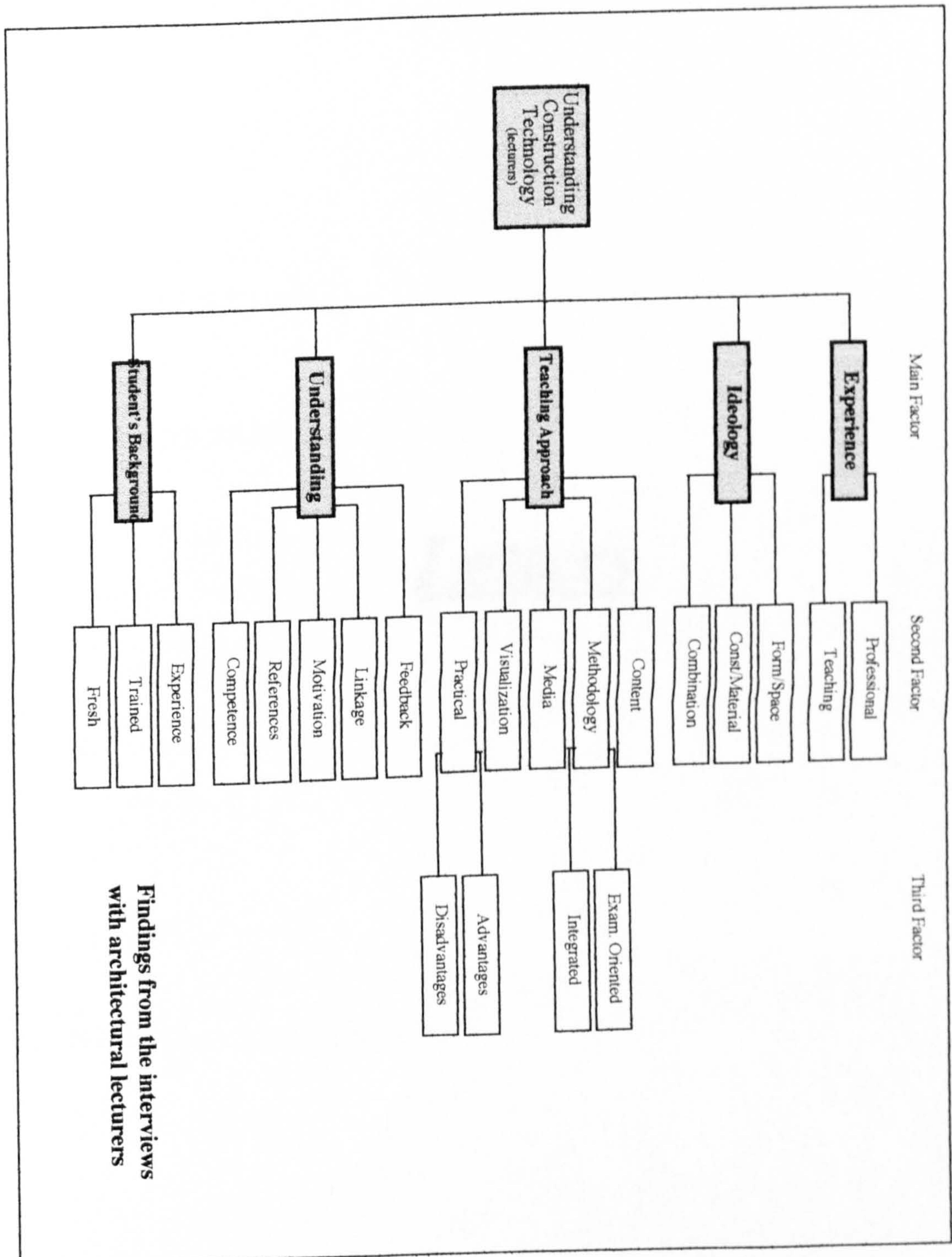
"Actually there are three categories or background of student in the architectural course. There are students graduated from The Polytechnics, Skilled trained students(IKM) and from technical colleges. The other batch are from form six(STPM) and from matriculation. Occasionally, we have very senior students which have been working for quite sometimes. But these seniors student ...they are good in design and may be construction is they have been working in the building field but they are normally lacking or have problems in the other subjects."

"In the design thesis assessment, marks were based on three aspects that is the functional aspect, the aesthetically aspect and third the technical and construction aspect. Most of the students pass on the functional aspects but failed in the technical and construction aspect. I found out that students spend so much time on the functional aspect and presentation but not on the technical... They always do last minutes work thus the technical aspect like the construction part is just done in order to fulfill the requirement. It is not thought carefully."

"The students that come out from polytechnic, because they are either matured in their age or they actually have the experience at least 6 months in the construction industry. So they usually come in with flying colours in my lectures... because like it or not construction is about experience and understanding... And the ones who are usually good will always help out the weaker ones and these in a way help us."

Summary:

- The lecturers tend to agree that students with considerable exposure in construction tend to excel in the subject construction technology. This could be due to their maturity and also exposure in the industry.
- In addition to that their performance in general is still not convincing.
- Motivation to learn is not very strong.



Letters

SCHOOL OF ARCHITECTURAL STUDIES

19 July 1996

TO WHOM IT MAY CONCERN

RADZYAH HAJI MOHD YUNUS

This is to certify that Radzyah Haji Mohd Yunus is a postgraduate student at The School of Architectural Studies, The University of Sheffield. She is currently attached to the Institut Teknologi Mara, and she intends to do her research on architectural education in Malaysia. Her focus will be on the gap which exists in terms of students' understanding on construction technology as part of the design process. The research will further extend to the application of modern computer based methods to this problem.

We would appreciate if you can provide her with the assistance in gathering vital information which will eventually provide a better understanding of this matter.

If required, we should be happy to furnish the report of the study once it is completed.

J. Jackson

PP Professor B. R. Lawson,
Head, School of Architectural Studies.



School of Architectural Studies, The University of Sheffield, The Arts Tower, Western Bank, Sheffield S10 2TN
Tel: 0114 276 8555, Fax: 0114 279 8276

Professor Bryan Lawson, Dip Arch (Oxford), MSc (Aston), PhD (Aston), RIBA, FRSA
Professor Peter Tregenza, B Arch, M Bdg Sc, PhD, MCIBSE, C.Eng., RIBA
Professor Peter Bhandall Jones, AADipl, MA Cantab

Professor Parid Wardi Sudin
Dean
Faculty of Built Environment
University Teknologi Malaysia
Johor
Malaysia
24th. July, 1996

Dear Professor,

**Research Interview: Learning/Teaching Construction
Technology in Architectural School in Malaysia**

I am a Malaysian Doctor of Philosophy student in Sheffield University and currently attached with Institut Teknologi MARA. I am carrying out a research into the learning and teaching construction technology in the architectural school in Malaysia.

The research involves in-depth study on the gap which exists in terms of students' understanding of construction technology as part of the design process. The research will further extends to the application of modern computer based methods to this problem. In order to complete the research I need to interview some of the students (preferably the second and fourth year student) and the lecturers involved in the teaching of construction and design in the architectural school.

No individual information will be disclosed but, if you would like to receive a copy of the overall results, please let me know and I would be pleased to furnish the report of the study once it is completed.

If you have no objection regarding the interview, I would like to contact you to fix the date once I am in Malaysia.

Attached herewith is a copy of endorsement letter from my supervisor, Professor Bryan Lawson. Thank you.

Yours faithfully

Rodzyah Haji Mohd Yunus
School of Architectural Studies
The University of Sheffield
The Arts Tower, Western Bank
Sheffield S10 2FX,
United Kingdom
Tel: 0114-2750225(UK)
010-5505205(Malaysia)

Professor Ibrahim Wahab
Dean of School of Housing, Building and Planning
University Sains Malaysia
Minden, Penang 11800
Malaysia
24th. July, 1996

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School of Architectural Studies
The University of Sheffield
The Arts Tower, Western Bank
Sheffield S10 2FX,
United Kingdom
Tel: 0114-2750225(UK)
010-5505205(Malaysia)

28th. January, 1997

Professor Madya Dr. Zulkifli Hanafi
Pengerusi Rancangan Seni Bina
School of Housing, Building and Planning
University Sains Malaysia
Minden, Penang 11800
Malaysia

Dear Sir,

**Ph.D Research Questionnaires: Learning/Teaching Construction
Technology in Architectural Schools in Malaysia**

First of all I would like to convey my thanks to the lecturers and the students for the informative interviews that was done in August 1996. However, I need to have a further questionnaires to be distributed among students and few lecturers. The filling of questionnaires will take about 10 to 15 minutes and will be conducted between 17 February and 17 March 1997.

If you have no objection regarding the above matter, I would like to contact you by telephone call to fix the date once I am in Malaysia.

Should you have any queries between 17 February 1997 and 17 February 1997, please do not hesitate to contact me at the following address:

229, Kota Lama Kiri
Kuala Kangsar, Perak
Tel: 010-5505205

Attached herewith is a copy of endorsement letter from my supervisor, Professor Bryan Lawson.

Finally; I would like to offer my sincere thanks for the cooperation and wishing you and all the staff in USM, "SELAMAT HARI RAYA AIDIL FITRI".

Thank you.

Yours faithfully

RODZYAH HAJI MOHD YUNUS
School of Architectural Studies
The University of Sheffield
The Arts Tower, Western Bank
Sheffield S10 2FX,
United Kingdom
email: r. b. yunus@sheffield.ac.uk

28. January, 1997

Encik Asrul Mahjuddin Ressang
Course Head (Architecture)
Department of Architecture
Faculty of Built Environment
University Teknologi Malaysia
Johor Bahru 80990
Negeri Johor Darul Ta'zim

Dear Sir,

**Questionnaires: Learning/Teaching Construction
Technology in Architectural School in Malaysia**

Thanks you for your reply letter ref. no: UTM. 21/25.10/3, dated 8 August 1996.

First of all I like to convey my thanks to the lecturers and the students for the informative interviews that was done in August 1996. However, I need to have a further questionnaires to be distributed among students and few lecturers. The filling of questionnaires will take about 10 to 15 minutes and will be conducted between 17 February and 17 March 1997.

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Thank you.

Yours faithfully

RODZYAH HAJI MOHD YUNUS
School of Architectural Studies
The University of Sheffield
The Arts Tower, Western Bank
Sheffield S10 2FX,
United Kingdom
email; r.b.yunus@sheffield.ac.uk

Dr. Mohd Rostam
Dean
School of Architecture Planning and Surveying
Institut Teknologi MARA
Shah Alam Selangor 40450
Malaysia
24th. July, 1996

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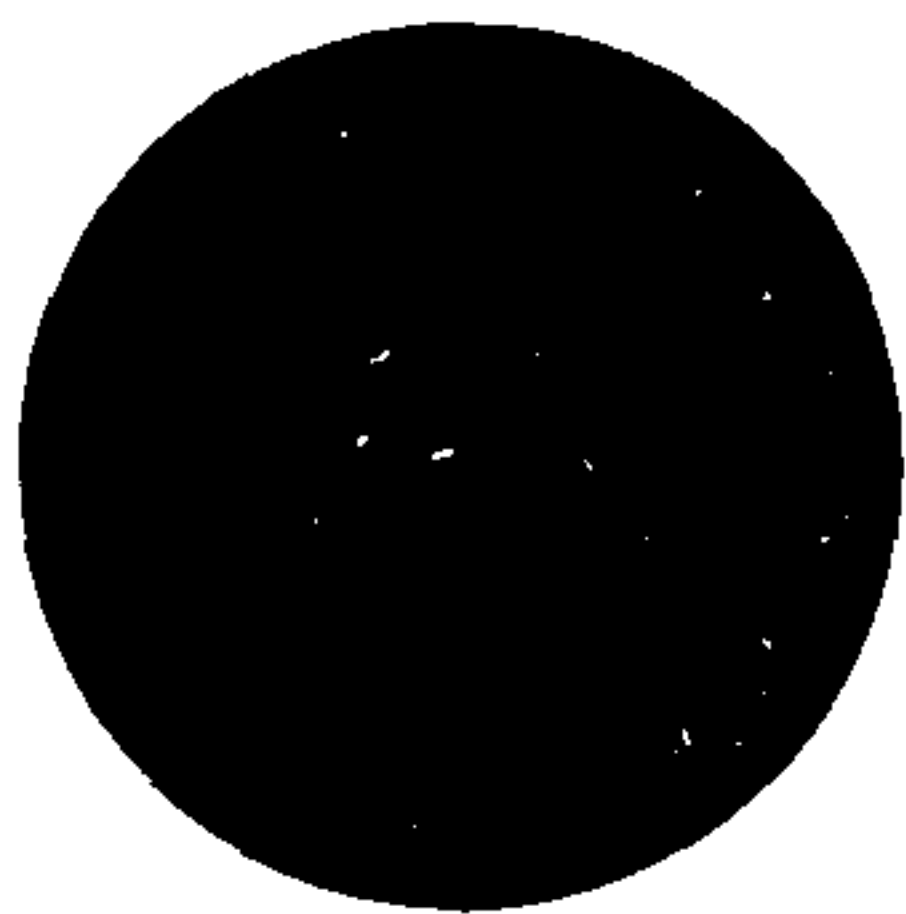
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TELEFON : 07-5576160

TELEFAX : 07-5568155

FAKULTI ALAM BINA

RUJ. KAMI (OUR REF.) :

UTM.21/25.10/3

8 August 1996

RUJ. TUAN (YOUR REF.) :

Miss Radzyah Haji Mohd. Yunus
School of Architectural Studies
The University of Sheffield
The Arts Tower, Western Bank
Sheffield S10 2FX
United Kingdom

Dear Madam,

**RESEARCH INTERVIEW: LEARNING/TEACHING CONSTRUCTION TECHNOLOGY
IN ARCHITECTURAL SCHOOL IN MALAYSIA**


We refer to your letter dated 24th July 1996 on the above.

Kindly be informed that in principle we have no objection for you to conduct the above research interview. Students will be most available during studio days which is on Monday or Friday. You are advise to carry out the above matter after the semester break which is 26 August 1996 onwards.

For any other queries please write in to us soonest possible.

Thank you.

Yours faithfully,


ASRUL MAHJUDDIN RESSANG
Course Head (Architecture)
Department of Architecture
for Vice Chancellor
(Tel no.: 07-5502604)

c.c. - Head of Department (Architecture)

PUSAT PENGAJIAN PERUMAHAN,
BANGUNAN DAN PERANCANGAN
11800 PULAU PINANG, MALAYSIA.



SCHOOL OF HOUSING,
BUILDING AND PLANNING,
11800 PENANG, MALAYSIA

UNIVERSITI SAINS, MALAYSIA

6 August 1996

Ms Rodzyah Haji Mohd. Yunus
School of Architectural Studies
The University of Sheffield
The Arts Tower, Western Bank
Sheffield S10 2FX
United Kingdom

Dear Ms Rodzyah,

**Research Interview: Learning/Teaching Construction Technology in
Architectural School in Malaysia**

Thank you for your letter of 24th. July 1996. It is interesting and encouraging to note that you are tackling a subject matter of great interest and concern to the country.

We would be indeed very happy to assist you in your research work. I have informed the respective Chairpersons (Architecture and Building Technology) about your intended visit. Please contact us with regard to your proposed research itinerary.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Amir Fawzi', written in a cursive style.

(Assoc. Prof. Dr. Amir Fawzi)

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SCHOOL OF HOUSING,
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11800 PENANG, MALAYSIA

UNIVERSITI SAINS MALAYSIA

3 August 1996

Ms. Rodzyah Haji Mohd Yunus
Post Graduate Research
School of Architectural Studies
The University of Sheffield, Sheffield S10 2TN,
UNITED KINGDOM

Dear Rodzyah,

**Research Interview at the School of Housing, Building and Planning
Universiti Sains Malaysia**

Thank you for your letter dated 24 July 1996 concerning your interest to carry out research interviews with some of the lecturers at the School of Housing, Building and Planning, USM.

We would very much welcome you to the School and happy to provide assistance and information which vital to your research.

Should you have any queries please do not hesitate to contact us.

With regards,

A handwritten signature in black ink, appearing to read 'A. Ghafar Ahmad'.

Dr. A. Ghafar Ahmad
Lecturer
email:aghafar@usm.my

p/s Send my regards to Ms. Doreen Spurr and Ms. J. Jackson